CALIFORNIA ENVIRONMENTAL PROTECTION AGENCY
REGIONAL WATER QUALITY CONTROL BOARD
COLORADO RIVER BASIN REGION

SEDIMENTATION/SILTATION TOTAL MAXIMUM DAILY LOAD FOR THE ALAMO RIVER

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Prepared by:
Regional Board Staff
Watershed Protection Branch

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LIST OF ACRONYMS AND ABBREVIATIONS

AF	acre-feet
AFY	acre-feet per year
Ag	agriculture
Ag Drains	Imperial Valley agricultural drains
AMC	Adaptive Management Committee
BMP	Best Management Practice
CDFA	California Department of Food and Agriculture
CDFG	California Department of Fish and Game
CEQA	California Environmental Quality Act
CFBF	California Farm Bureau Federation
CFR	Code of Federal Regulations
cfs	cubic feet per second
CWA	Clean Water Act, the Federal Water Pollution Control Act
CRBRWQCB	Colorado River Basin Regional Water Quality Control Board
CWC	California Water Code
CV	coefficient of variance
DDT	Dichlorodiphenyl trichloroethane
DDE	Dichlorodiphenyl dichloroethylene
DDD	Dichlorodiphenyl dichloroethane
DWQIP	(IID) Drain Water Quality Improvement Plan
EIFAC	European Inland Fisheries Advisory Council
FDA	Food and Drug Administration
FOTG	(NRCS) Field Office Technical Guide
FWQMP	Farm Water Quality Management Plan
IBWC	International Boundary and Water Commission
ICFB	Imperial County Farm Bureau
IID	Imperial Irrigation District
LA	Load Allocation
mg/L	milligram per liter
MOS	Margin of Safety
MSL	Mean Sea Level
NAS	National Academy of Sciences
NIWQP	National Irrigation Water Quality Program
NPDES	National Pollutant Discharge Elimination System
NPS	Nonpoint Source
NPS Plan	Plan for California's NPS Pollution Control Program
NRCS	Natural Resources Conservation Service

LIST OF ACRONYMS AND ABBREVIATIONS CONT.

NTU	nephelometric turbidity unit
OCPs	Organochlorine Pesticides
Porter-Cologne Act	California Porter-Cologne Water Quality Control Act
ppb	parts per billion
ppb-dw	parts per billion, dry weight
ppb-ww	parts per billion, wet weight
Regional Board	Regional Water Quality Control Board
STDEV	standard deviation
SWRCB	State Water Resources Control Board
TAC	Technical Advisory Committee
TMD	Trend Monitoring Data
TMDL	Total Maximum Daily Load
TSMP	Toxic Substances Monitoring Program
TSS	Total Suspended Solids
UCCE	University of California Cooperative Extension
USBR	United States Bureau of Reclamation
USEPA	United States Environmental Protection Agency
USGS	United States Geological Survey
WLA	Waste Load Allocation
WQO	Water Quality Objective
WQS	Water Quality Standard
WWTP	Waste Water Treatment Plant

EXECUTIVE SUMMARY

The Alamo River flows from the boundary between the United States and Mexico to the Salton Sea in Imperial County, California, and is the main tributary to the Salton Sea. The Alamo River's watershed has an extremely arid climate and consists almost entirely of highly productive agricultural lands irrigated with water imported from the Colorado River. The water in the Alamo River consists almost entirely of discharges from agricultural operations from the Imperial Valley.

The California Regional Water Quality Control Board, Colorado River Basin Region (Regional Board) listed the Alamo River on California's Clean Water Act Section 303(d) list as water quality limited because the river's current sediment load violates the water quality standards established by the Regional Board to protect the beneficial uses of the River. Excess delivery of suspended sediment to the Alamo River has resulted in degraded water quality conditions that impair the designated beneficial uses of the Alamo River. As the Alamo River discharges into the Salton Sea, excessive sediment also threatens the beneficial uses of the Salton Sea. Specifically, sediment serves as a carrier for DDT, DDT metabolites, and other insoluble pesticides including toxaphene, which pose a threat to aquatic and avian communities and people feeding on fish from the Alamo River. Also, the sediment in the Alamo River serves as a carrier for phosphates that are contributing to eutrophic conditions in the Salton Sea. The main sources of the suspended sediment and siltation of the Alamo River are agricultural return flows discharged into the river via agricultural drains operated and maintained by the Imperial Irrigation District.

Clean Water Act Section 303(d) requires the State to establish Total Maximum Daily Loads (TMDLs) for those pollutants causing water quality impairments to ensure that impaired waters attain their beneficial uses. This Sedimentation/Siltation TMDL for the Alamo River report (hereafter referred to as "TMDL Report") identifies the total allowable sediment loads for sources of sediment to the Alamo River, such that, when the allowable loads are achieved, they are expected to eliminate the impairments that sediment is currently causing. Regional Board staff is proposing that the Regional Board amend the Water Quality Control Plan for the Colorado River Basin (Basin Plan) to establish this TMDL and an implementation plan to achieve compliance with the TMDL. Specifically, this TMDL Report:

- Identifies the sediment loading problems that prompted TMDL development;
- Specifies an in-stream numeric target for total suspended solids for the River to ensure attainment of applicable water quality standards;
- Identifies and quantifies the sources of sediment to the Alamo River;
- Allocates allowable loads for the sources of sediment so that the numeric target is met and water quality standards are attained; and
- Describes the implementation plan necessary to achieve compliance with the TMDL.

The numeric target established by this TMDL is an annual average instream total suspended solids concentration of 200 milligrams per liter, applying along the entire length of the River. This target corresponds to about a 50% reduction of current annual mean suspended solids concentration in the Alamo at its outlet, where concentrations are the highest. The total sediment load to the Alamo River corresponding to the numeric target is approximately 175,000 tons per year. This total load is then allocated among the sources of sediment to the River. The load allocations contain a margin of safety to account for data uncertainty and are established for all drains discharging to each of six reaches of the Alamo, as well as for natural sources.

The implementation plan includes: (1) a description of the actions that agricultural dischargers in the watershed, the Imperial Irrigation District, and the United States Government (i.e., the responsible parties) must take to achieve the necessary reductions in sediment loading; (2) time schedules for actions to be taken by the responsible parties; and (3) a description of the monitoring and surveillance that will be used to determine progress toward attaining deadlines and milestones and to recommend adjustments to the TMDL as necessary. The implementation plan is based on the State's three-tiered approach for nonpoint source pollution control, that includes self-determined, regulatory encouraged, and regulatory tiers of nonpoint source pollution control. The TMDL is to be implemented in four phases, covering thirteen years. Each of the first three phases has an interim target to assess progress toward meeting water quality improvements. The TMDL will be reviewed every three years and adjusted, as appropriate, to account for new data and information, refine the components of this TMDL, and develop site specific objectives based on monitoring data for the TMDL and control measures.

Attached to this TMDL Report are:

- The proposed Basin Plan amendment to establish the TMDL and the implementation plan for the TMDL (Attachment 1);

- The proposed Regional Board Resolution to adopt the proposed Basin Plan amendment (Attachment 2);

- An analysis of potential environmental impacts of the adoption of the Basin Plan Amendment, as required by the California Environmental Quality Act (Attachment 3); and

- An analysis of potential economic costs to agriculture (Attachment 4).

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1. INTRODUCTION

The Alamo River watershed is located in the arid Sonoran desert of southeastern California, and, to a much lesser extent, of northern Baja California, Mexico. This watershed consists almost entirely of highly productive agricultural lands.. Due to the dry climate and intensive agricultural use of the watershed, the water in the Alamo River consists almost entirely of agricultural runoff. In spite of this, the waters of the Alamo River support diverse wildlife populations and a wide variety of human uses. These beneficial uses are currently impaired by excessive delivery of sediments. The purpose of the Alamo River Sedimentation/Siltation Total Maximum Daily Load (TMDL) is to protect the beneficial uses of the Alamo River by reducing the amount of polluted sediment that human-related activities are delivering to the river system.
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1.1 CLEAN WATER ACT SECTION 303(D) LIST AND TMDL PROCESS

Section 303(d)(A)(1) of the Clean Water Act (CWA) requires the California Regional Water Quality Control Board, Colorado River Basin Region (hereafter Regional Board), to:

- Identify the Region's waters that do not comply with water quality standards applicable to such waters after the application of technology-based effluent limits;
- Rank the impaired waterbodies, taking into account factors including the severity of pollution and the uses made of such waters; and
- Establish TMDLs for those pollutants causing the impairments to ensure that impaired waters attain their beneficial uses.

Title 40, Code of Federal Regulations (40 CFR), Section 130.3, defines a water quality standard as the water quality goals of a water body, or portion thereof, by designating the use or uses to be made of the water and by setting criteria necessary to protect those uses. A TMDL is defined as the sum of the individual waste load allocations (WLAs) for point sources of pollution, plus the load allocations (LAs) for nonpoint sources of pollution and natural background pollution, plus a margin of safety (MOS) such that the capacity of the waterbody to assimilate pollutant loadings without violating water quality standards is not exceeded. That is,

$$\text{TMDL} = \Sigma\text{WLA} + \Sigma\text{LA} + \text{MOS}$$

where Σ = the sum, WLA = waste load allocations, LA = load allocations (for natural and background sources) and MOS = margin of safety. A TMDL can be expressed in terms of either mass per time, toxicity, concentration, a specific chemical, or other appropriate measure [40 CFR 130.3(I)].

The Regional Board's current 303(d) list of impaired waters, adopted by the Regional Board and approved by the State Water Resources Control Board (State Board) in 1998, identifies the Alamo River as water quality limited, in part, because sediment concentrations violate the water quality standards (WQS) established by the Regional Board to protect the beneficial uses of the River. Such beneficial uses include: warm freshwater habitat (WARM); wildlife habitat (WILD); preservation of rare, threatened, and endangered species (RARE); and contact and non-contact recreation (REC I and REC II). The Regional Board's current 303(d) list identifies the Alamo

River as impaired by pesticides and selenium, and identifies the Salton Sea as impaired by salt, selenium and nutrients.

CWA Section 303(d) and 40 CFR Section 130.0 et seq., specifies the components and requirements of a TMDL. Essentially, the TMDL is a "pollution budget" developed to achieve water quality standards and must:

- Show how the TMDL will result in attainment of standards of concern in the specific waterbody;
- Identify and explain the basis for the total allowable load(s) such that the water body loading capacity is not exceeded;
- Identify and explain the basis for individual waste load allocations for point sources and load allocations for nonpoint sources of pollution;
- Explain how an adequate margin of safety is provided to account for uncertainty in the analysis; and,
- Account for seasonal variations and critical conditions concerning flow, loading, and other water quality parameters.

If the State fails to develop a TMDL, or if the United States Environmental Protection Agency (USEPA) rejects the State's TMDL, USEPA must develop one (CWA 303(d)(D)(2), 40 CFR 130(c)). Upon approval of the TMDL by USEPA, the Regional Board is required to incorporate the TMDL, along with appropriate implementation measures, into its Water Quality Control Plan (Basin Plan) (40 CFR 130.6(c)(1), 130.7). A TMDL should have the basic components shown in Table 1.1, below.

Table 1.1: Basic Technical TMDL Components

Component	Purpose
Problem Statement	Identifies the context for TMDL development and WQS issues that prompted TMDL development.
Numeric Target	Identifies specific instream goals and endpoints for the TMDL which ensure attainment of applicable WQS.
Source Analysis	Identifies and describes the magnitude and location of all significant point, nonpoint and background sources of the pollutant to the waterbody.
Loading Capacity Linkage Analysis	Specifies the critical quantitative link between applicable WQS and the TMDL. Loading capacity reflects the amount of a pollutant that may be delivered to the waterbody and still achieve WQS.
Load Allocations, Waste Load Allocations, Margin of Safety	Provides the calculations for total allowable loads and allocation of these loads among different sources such that applicable WQS are attained, while accounting for seasonal variation and uncertainty in the analysis of the data.
Monitoring Plan	Assesses TMDL implementation and effectiveness and provides for TMDL adjustment as needed.
Implementation Plan	Specifies nonpoint source Best Management Practices, point source controls, and other actions necessary to implement the TMDL.

Source: USEPA 1998, USEPA 2000

This TMDL identifies the allowable sediment loads for point and nonpoint sources of sediment discharges into the Alamo River, such that, when the allowable loads are implemented, they are projected to eliminate the impairments that sediment is currently causing.

1.2 PUBLIC PARTICIPATION

Public participation is a cornerstone of the TMDL process. This Sedimentation/Siltation TMDL has been developed with the benefit of significant public input. An advisory group, called the Imperial Valley Sedimentation/Siltation TMDL Technical Advisory Committee (Silt TMDL TAC), was formed in December 1998 to advise Regional Board staff regarding TMDL development and implementation. In support of the TAC, Regional Board staff prepared agendas; distributed minutes; attended and participated in meetings;[1] and prepared and distributed information materials, which included a "TMDL Binder" with all applicable laws and regulations, guidance documents, and fact sheets. The committee members are representatives from stakeholder agencies, groups and landowners, including:

- Audubon Society/Sierra Club
- Coachella Valley Water District
- Desert Wildlife Unlimited, Inc.
- Farmers from the Imperial Valley
- Imperial County Agricultural Commissioner
- Imperial County Farm Bureau and Imperial Valley Vegetable Growers Association
- Imperial Irrigation District
- Salton Sea Authority
- Salton Sea Science Subcommittee
- Sonny Bono Salton Sea National Wildlife Refuge
- State Board
- University of California Cooperative Extension, Holtville Field Station
- U.S. Bureau of Reclamation
- US Filter Corporation
- U.S. Fish and Wildlife Service

Members of this committee brought local knowledge and experience, as well as the concerns and viewpoints of various stakeholder groups that they represented, to the TMDL forum to aid in the development of Imperial Valley Sedimentation/Siltation TMDLs. The objective statement of the Silt TMDL TAC was to: advise Regional Board staff with respect to the development and implementation of silt TMDLs for the Ag Drains, and the New and Alamo Rivers in a timely fashion; and provide expert resources, scientific evaluations and recommendations on TMDL documents (e.g., problem statement, draft TMDLs, implementation plans).

Since 1998, Regional Board staff have conducted public outreach regarding the development and implementation of this TMDL through presentations to the Board of Directors of the Imperial Irrigation District, to tribal nations during the annual nonpoint source pollution prevention workshops sponsored by USEPA, to students and faculty of Imperial Valley Community College, to the Salton Sea Authority Technical Committee, to the Salton Sea Science Subcommittee, and during annual Salton Sea Symposiums. This draft TMDL is being circulated for public review and comment before consideration of adoption by the Regional Board during a public hearing.

[1] The TAC met : January 12, 1999; February 1, 1999; March 15, 1999; April 19, 1999; May 17, 1999; June 21, 1999; August 2, 1999; September 20, 1999; October 18, 1999; January 19, 2000; February 9, 2000; March 20, 2000; and April 17, 2000.

2. PROBLEM STATEMENT

The Alamo River, unlike most rivers in the world, is sustained and dominated by agricultural return flows. These flows are either discharged directly into the Alamo River or into the Imperial Valley Agricultural Drains (hereafter "Ag Drains") operated and maintained by the Imperial Irrigation District (IID). Sediment is present in the Alamo River at concentrations that violate the water quality standards (WQS) the Regional Board has established for the River. This problem statement describes the hydrogeological and biological setting, and specifies reasons why sediment needs to be addressed (i.e. water quality standards regarding sediment, and impairments caused by sediment).

2.1 WATER QUALITY STANDARDS

Water quality standards (WQS), pursuant to 40 CFR 130.2(d) and California Water Code (CWC) 13241, consist of beneficial uses and the water quality criteria (aka water quality objectives in the CWC) based on such uses. WQS adopted for the Colorado River Basin Region are contained in the Water Quality Control Plan for the Colorado River Basin Region (CRWQCB 7, 1994). The WQS for the Alamo River are comprised of the beneficial uses of water and the water quality objectives (WQOs). The WQOs are either numerical or narrative and are designed to protect the most sensitive beneficial uses. For the Alamo River, the most sensitive designated beneficial uses to be addressed in the Sedimentation/Siltation TMDL include: warm freshwater habitat (WARM); wildlife habitat (WILD); preservation of rare, threatened, and endangered species (RARE); and contact and non-contact recreation (REC I and REC II). Tables 2.1 and 2.2, below, summarize the beneficial uses and water quality objectives addressed in this TMDL.

Table 2.1: Beneficial Uses Addressed in Sedimentation/Siltation TMDL for Alamo River

Designated Beneficial Uses of Water	Description
Warm Freshwater Habitat (WARM)	Uses of water that support warm water ecosystems including, but not limited to, preservation or enhancement of aquatic habitats, vegetation, fish, or wildlife, including invertebrates.
Wildlife Habitat (WILD)	Uses of water that support terrestrial ecosystems including, but not limited to, the preservation and enhancement of terrestrial habitats, vegetation, wildlife (e.g., mammals, birds, reptiles, amphibians, invertebrates), or wildlife water and food sources.
Preservation of Rare, Threatened, and Endangered Species (RARE)	Uses of water that support habitats necessary, at least in part, for the survival and successful maintenance of plant or animal species established under State or Federal law as rare, threatened or endangered.
Water Contact Recreation (REC I)[2]	Uses of water for recreational activities involving body contact with water, where ingestion of water is reasonably possible. These uses include, but are not limited to, swimming, wading, water-skiing, skin and scuba diving, surfing, white water activities, fishing, and use of natural hot springs.

[2] The only known REC I usage is infrequent fishing activity.

Designated Beneficial Uses of Water	Description
Non-Contact Recreation (REC II)	Uses of water for recreational activities involving proximity to water, but not normally involving contact with water where ingestion of water is reasonably possible. These uses include, but are not limited to, picnicking, sunbathing, hiking, beachcombing, camping, boating, tidepool and marine life study, hunting, sightseeing, or aesthetic enjoyment in conjunction with the above activities.

Source: California Regional Water Quality Control Plan for the Colorado River Basin Region (CRWQCB 7,1994)

Table 2.2: Summary of WQOs Addressed by Sedimentation/Siltation TMDL for Alamo River

Parameter	Water Quality Objective
Suspended Solids	Discharges of wastes or wastewater shall not contain suspended or settleable solids in concentrations which increase the turbidity of receiving waters, unless it can be demonstrated to the satisfaction of the Regional Board that such alteration in turbidity does not adversely affect beneficial uses.
Sediment	The suspended sediment load and suspended sediment discharge rate to surface waters shall not be altered in such a manner as to cause nuisance or adversely affect beneficial uses.
Turbidity	Waters shall be free from changes in turbidity that cause nuisance or adversely affect beneficial uses.
Chemical Constituents	No individual chemical or combination of chemicals [e.g., chlorinated pesticides] shall be present in concentrations that adversely affect beneficial uses. There shall be no increase in hazardous chemical concentrations found in bottom sediments or aquatic life.
Biostimulatory Substances	Waters shall not contain biostimulatory substances [e.g., phosphate] in concentrations that produce aquatic growths to the extent that such growths cause nuisance or adversely affect beneficial uses.

Source: California Regional Water Quality Control Plan for the Colorado River Basin Region (CRWQCB 7,1994)

2.2 HYDROGEOLOGICAL SETTING

2.2.1 ALAMO RIVER

The Alamo River watershed encompasses approximately 340,000 acres within the Imperial Valley. Land uses within the watershed consist chiefly of irrigated farmland, with minor amounts of urban and industrial land uses, and confined animal feeding operations. The Alamo River has its headwaters about 0.6 river-miles south of the International Boundary. The River flows northward roughly 60 river-miles through the Imperial Valley, eventually emptying into the southeast corner of the Salton Sea, just southwest of the community of Niland. The flow at the International Boundary is between two (2) and five (5) cubic feet per second (cfs) [1,444 and 3,610 acre-feet per year (AFY)]. The flow of the River rapidly increases as it travels through the Imperial Valley where it is fed by over 900 miles of Ag Drains. The flow of the Alamo River at its outlet into the Salton Sea ranges from a maximum of about 1,700 cfs to a minimum of about 350 cfs, and averages about 900 cfs (about 650,000 AFY), based on flow data from 1994 through 1999 (Huston et al. 2000). The Alamo River is the Salton Sea's largest tributary, contributing about 50% of the Sea's annual inflows, and therefore has a major influence on the water quality of the Sea. The Alamo River flows from an elevation of about 10 feet above mean sea level at the International Boundary to an elevation of about 227 feet below mean sea level at the Salton Sea (depending on the level of the Salton Sea, which fluctuates based on agricultural return flow discharges and seasonal evapotranspiration rates). Thirteen drop structures have been installed in the Alamo channel by IID and the U.S. Bureau of Reclamation to control its flow to reduce flooding and erosion (IID 2000). The average height of these drop structures is about six feet, thus effectively reducing the slope of the River to about 2.9 feet per river-mile, or about 0.05% (Huston et al. 2000). Figure 2.1 shows the Alamo River downstream of the town of Brawley, and Figure 2.2 shows a discharge of tailwater into an Ag Drain.

Figure 2.1: Alamo River Downstream of Brawley

Figure 2.2: Discharge of Tailwater to Ag Drain

2.2.2 THE SALTON SEA TRANSBOUNDARY WATERSHED

The Alamo River watershed is a sub-watershed of the Salton Sea Transboundary Watershed. The Salton Sea Transboundary Watershed encompasses about 8,360 square miles and contains five (of six) of the Region's impaired surface waterbodies. Most of the watershed is in Imperial County, but it also receives drainage from Coachella Valley in Riverside County and the Mexicali Valley in Mexico (via the New River and to a much smaller extent the Alamo River). Watershed boundaries are illustrated in Figure 2.3.

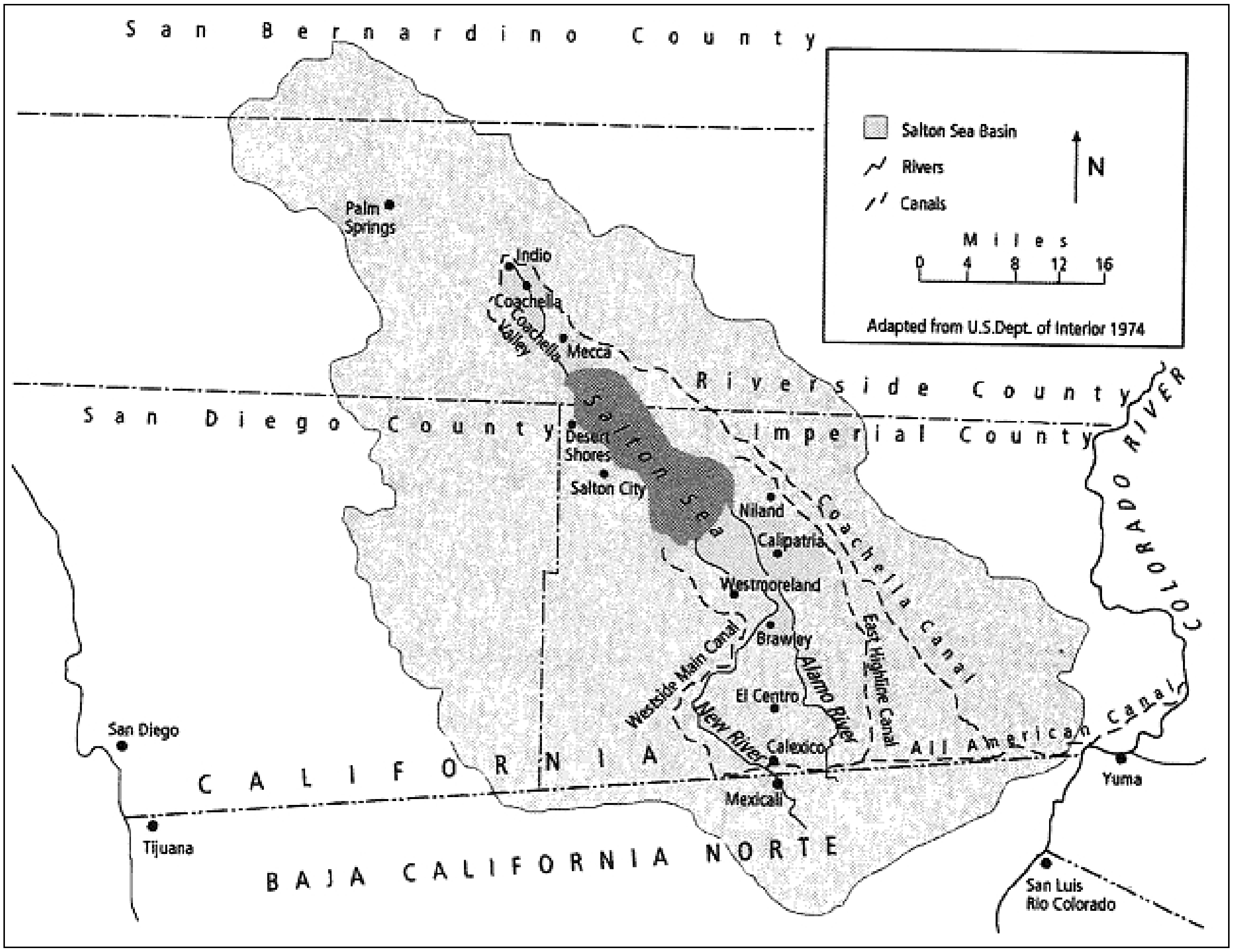

Figure 2.3: Salton Sea Transboundary Watershed
Source: Cohen et al. 1999

Water quality issues in the Salton Sea watershed occur in four geographical areas: Coachella Valley, Salton Sea, Imperial Valley, and Mexicali Valley. The most significant water quality problems within the U.S. portion of the watershed are associated with the Salton Sea and its major tributaries: the New and Alamo Rivers and the Ag Drains, all in Imperial Valley. Table 2.3, located on the following page, lists the current Section 303(d) pollutants for the aforementioned surface waters.

Table 2.3: 303(d) Listed Imperial Valley Waterbodies & Impairing Pollutants

Waterbody	Pollutants of Concern
Imperial Valley Agricultural Drains	Sediment, Pesticides, Selenium
Alamo River	Sediment, Pesticides, Selenium
Salton Sea	Selenium, Salt, Nutrients
New River	Sediment, Pesticides, Bacteria, Nutrients, Volatile Organic Compounds (VOCs)

The Salton Sea is California's largest lake and has been famous for its sport fishery, recreational uses, and habitat for hundreds of species of birds. The Sea is about 35 miles long and 9 to 15 miles wide with approximately 380 square miles of water surface and 105 miles of shoreline. The surface of the Sea lies approximately 227 feet below Mean Sea Level (MSL).

The Salton Sea is a designated sump for agricultural wastewater from the Imperial and Coachella Valleys. In 1924 and 1928, then President Calvin Coolidge executed Public Water Reserve Order Numbers 90 and 114, respectively, for withdrawal of 123,360 acres of public land lying at an elevation of 220 feet below MSL, in and surrounding the Salton Sea. These lands were designated as a repository to receive and store agricultural, surface and subsurface drainage waters. The State of California designated the Sea for this same purpose in 1968. Currently, the Sea is approximately 25% saltier than the ocean, with salinity increasing at approximately 1% per year. It is also an extremely eutrophic lake.

2.3 BIOLOGICAL SETTING

The Salton Sea Transboundary Watershed (Figure 2.3) provides important habitat for many different kinds of wildlife. This area sustains intricate food webs that incorporate many terrestrial and aquatic elements, including plants, invertebrates, fish, rodents, turtles, frogs, and birds. Organisms at the base of the food web are consumed by organisms at the next highest trophic level. These organisms then are consumed by the next highest trophic level, and so on until the top of the food web has been reached.

The Watershed is a major center for avian biodiversity in the American Southwest, supporting over 350 species and averaging over 1.5 million birds annually. Table 2.4 lists the Sensitive Species of the Alamo River and Alamo River Delta.

Table 2.4: Sensitive Species of the Alamo River and Alamo River Delta

Common Name	Scientific Name	Status
Desert pupfish	*Cyprinodon macularius*	SES/FE
California brown pelican	*Pelecanus occidentalis californicus*	SES/FE
Southwestern willow flycatcher	*Empidonax traillii extimus*	SES/FE
California least tern	*Sterna antillarum browni*	SES/FE
Least Bell's vireo	*Vireo bellii pusillus*	SES/FE
Greater sandhill crane	*Grus canadensis tabida*	FT

Yuma clapper rail	*Rallus longirostris yumanesis*	STS-FP/FE
Southwestern willow flycatcher	*Empidonix traillii extimus*	SES/FE
Tri-colored blackbird	*Agelaius tricolor*	SSSC
Burrowing owl	*Athene cunicularia*	SSSC
Least bittern	*Ixobrychus exilis*	*FSSC*
Loggerhead shrike	*Lanius ludovicianus*	*FSSC*
Yellow warbler	*Dendroica petechia*	*FSSC*
Van Rossem's gull-billed tern	*Sterna nilotica vanrossemi*	SSSC
Caspian tern	*Sterna caspia*	SSSC
Black skimmer	*Rynchops niger*	SSSC
California black rail	*Laterallus jamaicensis coturniculus*	STS-FP
Cooper's hawk	*Accipter cooperti*	SSSC
Sharp-shinned hawk	*Accipter striatus*	SSSC
Short-eared owl	*Asio flammeus*	SSSC
Long-eared owl	*Asio otus*	SSSC
Sensitive Habit type: Southern Willow Scrub		

Legend:

FE = Federal endangered species
FSSC = Federal species of special concern
FT = Federal threatened species
SES = State endangered species
STS-FP = State threatened species that is fully protected
SSSC = State species of special concern

The Salton Sea Transboundary Watershed includes the Salton Sea, Alamo River, New River and Imperial Valley Ag Drains, among other waterways. The Alamo River and New River are the primary tributaries to the Salton Sea. The current inflow into the Sea is about 1.3 million acre-feet/year (AFY), with the Alamo River contributing roughly 650,000 AFY, or 50% of the inflow. Thus, the Alamo River plays an integral role in the Salton Sea's biological systems.

2.3.1 BIOLOGICAL SETTING OF THE SALTON SEA

The aquatic ecosystem of the Salton Sea is vastly different from that of the Alamo River, New River, and Ag Drains, despite the Sea receiving agricultural discharges and other relatively freshwater flows from these waterways. This is due to biological, physical and chemical differences, the most important being the high salinity level of the Sea. Species that reside in and at the Sea are generally much more salt tolerant than species residing within the drainage network.

The Salton Sea supports numerous marine, freshwater or estuarine fish species that have extreme salinity tolerances. These fish include the sailfin mollie, longjaw mudsucker, mosquitofish, tilapia (several species), bairdiella, sargo, orange-mouth corvina and desert pupfish (Salton Sea Authority and USBR 2000). Many fish species were introduced from the Gulf of California by the California Department of Fish and Game and have formed a highly productive sport fishery. Fish make up the entire submerged megafauna of the Salton Sea (Salton Sea Authority and USBR 2000). The Sea's aquatic food web consists mainly of fish that feed on sediment-dwelling (bottom) organisms.

The only special status fish species in the area is the desert pupfish, which occurs in drainages and washes adjacent to the Salton Sea. This species is state and federally endangered, and is the Sea's only native fish species. Desert pupfish eat algae, minute organisms associated with detritus, insects, fish eggs and small crustaceans. Desert pupfish have been observed moving upstream into drains, indicating the importance of Ag Drain tributaries as pupfish habitat (Salton Sea Authority and USBR 2000).

Nitrogen and phosphorus from agricultural drainage inflows create extreme eutrophic conditions in the Sea. These conditions provide a rich environment for the lowest trophic levels, the primary producers in the Sea, comprised mainly of phytoplankton found in the water column and phytobenthos (microscopic plants) found in benthic habitats (Salton Sea Authority and USBR 2000). Algae provide a valuable food source for introduced species of fish in the Sea. However, in the summer when algal activity is high, organic decomposition and plankton blooms result in decreased dissolved oxygen. Such conditions are implicated in fish die-offs.

The Salton Sea is a critical stop on the ecologically important Pacific Flyway for migrating birds, and supports several state and federally endangered and threatened species. More than 350 birds species winter at the Sea, in one of the few remaining wetland environments along the Pacific Flyway (US Fish and Wildlife Service 1997). The Salton Sea National Wildlife Refuge is located at the southern end of the Salton Sea, where the Alamo River forms the Sea's delta. The Refuge was established in 1930 to preserve wintering habitat for migratory birds, and to provide forage areas to limit crop damage caused by migratory and resident birds.

The Sea is an increasingly important habitat for birds because about 97% of California's wetlands have been converted to other uses or otherwise degraded (US Fish and Wildlife Service 1999). Salton Sea bird communities represent a significant proportion of the breeding populations of many species (Salton Sea Authority and USBR 2000). Water birds represent the higher trophic levels of the area's food. The birds' primary food sources are fish and aquatic invertebrates in the Sea itself. Other food sources are found along shorelines and in adjacent fresh/brackish water wetlands and agricultural drainage systems, and include aquatic plants, terrestrial invertebrates, amphibians, and reptiles. The Sea's most common water bird species is the eared grebe, followed by the black-necked stilt, American avocet, and ring-billed gull.

2.3.2 BIOLOGICAL SETTING OF THE ALAMO RIVER AND IMPERIAL VALLEY AGRICULTURAL DRAINS

The Alamo River and Imperial Valley Agricultural Drains have similar habitats because of similar physical (hydrologic and geologic) and chemical (water and sediment) properties. This habitat supports a substantially different aquatic ecosystem than that of the Salton Sea, and rivals the Sea in species diversity. Birds are the most diverse wildlife group using the Alamo River and its tributary Ag Drains, as indicated by their abundance and species richness. Fish provide sustenance and recreational benefits to Alamo River users, as well as food for numerous bird species.

The Alamo River and Ag Drain ecosystem exhibits two food webs, one for the aquatic environment and one for the terrestrial environment, although these two webs overlap. The aquatic food web includes freshwater and brackish water species. Plankton, detritus and aquatic vegetation are at the base of the food web. These organisms are consumed by aquatic invertebrates such as snails, waterboatmen and insect larvae. The most prevalent invertebrates are the thyrid and physid snails found in bottom sediments, and larvae of the insect family chironomidae found in the water column (US Fish and Wildlife Service 1997). The thyrid snail was the most abundant taxa in eight of ten Ag Drains in a 1993 survey (Setmire et al. 1999). Chironomids are an important food source for drain fish and shorebirds, including the endangered Yuma clapper rail and desert pupfish (US Fish and Wildlife Service 1997).

Aquatic invertebrates are then consumed by the next highest trophic level represented by crayfish, Asiatic river clams and fish. (Some fish also may consume plankton directly.) Fish present in the Alamo River and Ag Drains include the desert pupfish (state and federally endangered), mosquitofish, carp, longjaw mudsucker, red shiner, sailfin mollie, largemouth bass, catfish (several species) and tilapia (several species) (US Fish and Wildlife 1997, DFG 1975, CRWQCB 1975-to date, and SWRCB 1978-1995). Orangemouth corvina and striped mullet are found in the Alamo River Delta (Keeney 2000).

Turtles and birds are at the top of the local aquatic food chain. Turtles, such as the spiny softshell turtle, prey on desert pupfish and aquatic invertebrates including Asiatic river clams. Many bird species feed on crayfish, clams, other aquatic invertebrates, fish and aquatic vegetation. These birds include the ruddy duck, American coot, northern shoveler, great blue heron, cattle egret, great egret and Yuma clapper rail, among others.

Generally, waterfowl and shorebirds are seen at the mouth of the Alamo River (Setmire et al. 1993). Common species include the black-necked stilt, American avocet, cattle egret, white-faced ibis, and double-crested cormorant. Figure 2.4 illustrates the Imperial Valley agricultural ecosystem, as a flock of white-faced ibis flies above an alfalfa field on its way to the Salton Sea.

Figure 2.4: A Flock of White-Faced Ibis above an Alfalfa Field in the Imperial Valley

The terrestrial food chain involves plants, flying invertebrates, songbirds and rodents (US Fish and Wildlife Service 1997 and IID 1994). Songbirds are the most common species using the Alamo River and its tributary Ag Drains. Red-winged blackbirds, yellow-rumped warblers and savannah sparrows are the most common.

The Ag Drains are inhabited by at least thirteen (13) fish species (IID 1994). The state and federally endangered desert pupfish was found in twenty-four (24) of twenty-nine (29) Ag Drains sampled by the California Department of Fish and Game in 1994 (Keeney 2000). All twenty-four (24) of these drains emptied directly into the Salton Sea.

Ag Drain banks are used for forage and shelter by reptiles, insects, and birds (US Fish and Wildlife Service 1997). The burrowing owl, a State species of concern, nests in drain banks. Please see Attachment 3 A - Natural Environment Study for more information on biological impacts.

2.4 WEATHER

The Imperial Valley is located in the Colorado Desert region of the Sonoran Desert. The climate is characterized by hot, dry summers, occasional thunderstorms, and gusty high winds with sandstorms. It is one of the most arid areas in the United States, with an average annual rainfall of about 3 inches and temperatures in excess of 100ºF for more than 100 days per year. The average January temperature is 54ºF and the average July temperature is 92ºF. Evapotranspiration rates for the Imperial Valley can exceed 7 feet per year and, in hot summer months, can be one-third inch per day. The frost-free period is greater than 300 days per year for 9 of 10 years, and greater than 350 days per year for 3 of 10 years (Setmire et al. 1990).

2.5 LAND USES IN IMPERIAL COUNTY

Imperial County covers approximately 4,597 square miles (2,939,453 acres) (Imperial County General Plan, 1993). About 74% of County lands are undeveloped desert and mountain areas, mostly under the ownership of the Federal or State government. The Salton Sea covers about 8% of the County. About 17% of County lands are irrigated for agriculture, totaling over 500,000 acres located mostly in the Imperial Valley (IID 1999a). Cities, communities and support facilities occupy less than 1% of County land. Table 2.5, located on the following page, shows the general land uses in Imperial County.

Table 2.5: Imperial County Land Use Distribution

Land Use	Acres	Data Source
Irrigated (Agriculture)		
Imperial Valley	479,327	IID, 1999a
Bard Valley	14,737	Imperial County, 1998
Palo Verde	7,428	Imperial County, 1998
Developed		
Incorporated	9,274	Imperial County, 1998
Unincorporated	8,754	Imperial County, 1998
Desert/Mountains		
Federal	1,459,926	Imperial County, 1998
State	37,760	Imperial County, 1998
Indian	10,910	Imperial County, 1998
Private	669,288	Imperial County, 1998
Other		

Salton Sea	242,049	Salton Sea Authority and USBR, 2000

2.5.1 AGRICULTURE IN THE IMPERIAL VALLEY

Approximately 480,000 acres within the Imperial Irrigation District are considered farmable (IID 1999a). From 1964 through 1998, IID distributed between 2.6 and 3.2 million acre-feet of Colorado River water per year for irrigation purposes. The major crops in the Valley, based on the amount of land in production, are alfalfa, wheat, sudan grass, and sugar beets (Imperial County Agricultural Commissioner 1993-1998). Imperial Valley has an agricultural based economy, and is the tenth-ranked agricultural county in the State of California, producing over $1 billion dollars in revenue annually (CDFA 1998). One in every three jobs in the Valley is related to agriculture (IID 1998c). For every $1,000 of total gross value produced in the agriculture sector, $345 of personal income is generated from agriculturally related jobs (Imperial County Agricultural Commissioner 2001).

Surface (gravity) or flood irrigation is the dominant irrigation method in the Imperial Valley. Two types of surface irrigation are practiced: furrow irrigation and border irrigation. For both furrow and border irrigation methods in the IID, water is delivered to an individual field's head canal via the All-American Canal and a series of delivery canals. Each field's head canal contains a gated pipe (head gate), which, when open, conveys irrigation water via gravity either directly onto a field or into small holding ponds at the top end (head end) of the field.

In furrow irrigation, siphon tubes convey water from the holding ponds into small channels, known as furrows (Figure 2.5). Water infiltrates the soil from the bottom and sides of the furrows, and moves downward and laterally. Furrow irrigation is suitable to crops that are subject to injury if water covers their crowns or stems, such as vegetables, cotton, corn, sugar beets, potatoes, and seed crops.

Border irrigation is accomplished by running water between two borders, which are essentially small earthen berms. The area between the two borders is called a border strip, which may vary from 10 to 100 feet in width and from 300 to 2,600 feet in length. Gated pipes and siphon tubes conduct water from delivery channels into each border strip either directly or through temporary small ponds installed between water inlets and the border strip. Border irrigation is generally used for crops that are not sensitive to wet soils around their stems, such as alfalfa, sudan grass, and maize.

Figure 2.5: Surface (Flood) Irrigation on a Field Planted in Furrows

2.6 SOIL CLASSIFICATIONS

All of the major soils associations within the Imperial Valley are within the "wet" series of poorly drained soils due to their low permeabilities (less than 0.5 inches per hour). The Imperial Valley is dominated by three general soil associations: Imperial (nearly level, moderately well drained silty clay), Imperial-Holtville-Glenbar (nearly level, moderately well drained and well drained silty clay, silty clay loam, and clay loam), and Meloland-Vint-Indio (nearly level, well drained fine sand, loamy very fine sand, fine sandy loam, very fine sandy loam, loam and silt loam) (Zimmerman 1981). The Soil Conservation Service (now known as the Natural Resources Conservation Service) soil descriptions are in Appendix A.

2.7 PROBLEM STATEMENTS/SUMMARY OF EXISTING CONDITIONS

2.7.1 GENERAL PROBLEM STATEMENT

Excess delivery of sediment to the Alamo River has resulted in degraded conditions that impair the following designated beneficial uses: warm freshwater habitat; wildlife habitat; preservation of threatened, rare, and endangered species habitat; contact and non-contact recreation; and freshwater replenishment. As the Alamo River discharges into the Salton Sea, sediment also threatens the beneficial uses of the Salton Sea. Specifically, sediment serves as a carrier for DDT, DDT metabolites, and other insoluble pesticides including toxaphene, which pose a threat to aquatic and avian communities, and people feeding on fish from the Alamo River. Suspended solids concentrations, sediment loads, dissolved oxygen, and turbidity levels in the Alamo River are in violation of water quality objectives. These current concentrations, loads, and levels are also forming objectionable bottom deposits, which are also adversely affecting the beneficial uses of Alamo River.

2.7.2 SEDIMENT TRANSPORT AS A MECHANISM FOR DDT, DDT METABOLITES, AND TOXAPHENE MOBILIZATION, AND FORMATION OF BOTTOM DEPOSITS, WHICH VIOLATE WATER QUALITY STANDARDS

DDT[3] is an insecticide that was widely used in the United States after 1942. The breakdown products of DDT include the metabolites DDE[4] and DDD[5]. The sum of DDT, DDE, and DDD are commonly referred to as “Total DDT.” DDT, DDE, and DDD are known carcinogens and are listed in the Governor’s Proposition 65 List of Chemicals Known to the State of California to Cause Cancer or Reproductive Toxicity. DDT is also a recognized developmental toxicant. DDT was banned in the United States in 1973 and in Mexico in 1983.

DDT was used extensively in the Imperial Valley as a low cost, broad-spectrum insecticide (Setmire et al. 1993). The pesticide dicofol, which is currently in use in the Imperial Valley, contains DDT. Before 1986, dicofol products contained DDT at concentrations as high as 15% (EPA 1998). Since 1987, registered dicofol products were required to contain less than 0.1% DDT. The presence of DDT in dicofol may contribute DDT metabolites to the environment of the Imperial Valley.

DDT and its metabolites are strongly hydrophobic (water-fearing) organochlorine pesticides. As such, they have an affinity for absorption by the negatively-charged clay-rich sediments entering the Alamo River. Therefore, DDT and its metabolites are transported into the surface water system along with sediment. DDT compounds are mobilized by tailwater runoff, which carries soil with the absorbed metabolites, or by resuspension of sediment in the Ag Drains and rivers.

DDT metabolites have been detected in bottom sediment samples in the Alamo River (Setmire et al. 1990, Setmire et al. 1993, Eccles 1979). DDE (the main metabolite in the breakdown of DDT) is the metabolite detected in the greatest concentrations in aquatic organisms (SWRCB 1978-1995). DDT and its metabolites have low water solubility and high lipophilicity (i.e., propensity to attach to lipid molecules). These properties allow DDT and its breakdown products to bioaccumulate in fish and wildlife, with severe consequences for wildlife at the top of the food chain.

Fish and bird specimens from the Alamo River routinely show some of the highest DDE concentrations in the State of California (SWRCB 1978-1995, USEPA 1980, Ohlendorf et al. 1984, Mora et al. 1987). Measured Total DDT concentrations in fish tissue exceed the National Academy of Sciences (NAS) recommended maximum concentration and the U.S. Food and Drug Administration (FDA) Action Level. NAS guidelines are meant to protect species that consume DDT at all levels of the food chain; the guideline is 1,000 parts per billion, wet weight (ppb-ww). FDA Action Levels are meant to protect humans from chronic effects of DDT consumption, and are based on the quantity and frequency of food consumption; the guideline is 5,000 ppb-ww.

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[3] Dichlorodiphenyl trichloroethane

[4] Dichlorodiphenyl dichloroethylene

[5] Dichlorodiphenyl dichloroethane

Reproductive success of colonial nesting birds has declined at the Salton Sea. This is likely related to the high levels of multiple contaminants, particularly organochlorine pesticides, in eggs (Bennett 1998). DDE-caused reproductive depression in birds has emerged as a serious concern in the Salton Sea area, according to a report by the U.S. Department of the Interior National Irrigation Water Quality Program (Bennett 1998).

Figure 2.6: TSM Sampling of Alamo River, Dec. 1992

The Toxic Substances Monitoring (TSM) Program has been in effect since 1978. This program provides a uniform approach to the detection and evaluation of toxic substances in waters of the State. The California Department of Fish and Game carries out the TSM Program for the State Board by analyzing fish and other aquatic organisms from selected sampling stations (Figure 2.6). Composite samples, using a minimum of six organisms of each species, are used whenever possible. Analysis of the same species from the same station is desirable to minimize possible variation in the data due to differences in pollutant uptake between species.

Tables B-1, B-2, and B-3 in Appendix B show TSM DDT results. Table B-1 summarizes DDT concentrations by fish species in the Imperial Valley. For comparison purposes, Table B-2 shows DDT concentrations for all monitored surface waters in the Region. Table B-3 summarizes DDT concentrations by fish species in the Alamo River. The NAS recommended guideline for Total DDT is 1000 ppb-ww, and the FDA Action Level is 5,000 ppb-ww. A summary of the data tables follows.

- Alamo River fish samples exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 27. Mean concentration of Total DDT was 2816 ppb-ww, and maximum was 9153 ppb-ww. About 78% of samples exceeded the NAS recommended guideline, and about 19% of samples exceeded the FDA Action Level (Table B-2).

- Fish samples from the Ag Drains exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 30. Mean concentration of Total DDT was 1087 ppb-ww, and maximum was 5106 ppb-ww. About 30% of samples exceeded the NAS recommended guideline, and about 3% of samples exceeded the FDA Action Level (Table B-2).

- Salton Sea fish samples did not exceed the NAS recommended guideline or FDA Action Level for Total DDT. Total sample size was 21. Mean concentration of Total DDT was 97 ppb-ww, and maximum was 276 ppb-ww (Table B-2).

- Colorado River fish samples did not exceed the NAS recommended guideline or FDA Action Level for Total DDT. Total sample size was 17. Mean concentration of Total DDT was 102 ppb-ww, and maximum was 855 ppb-ww (Table B-2).

- Carp (*Cyprinus carpio*) from the Alamo River exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 12. Mean concentration of Total DDT was 3833 ppb-ww, and maximum was 9153 ppb-ww. About 92% of samples exceeded the NAS recommended guideline, and about 33% of samples exceeded the FDA Action Level (Table B-3).

- Channel catfish (*Ictalurus punctatus*) from the Alamo River exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 12. Mean concentration of Total DDT was 2280 ppb-ww, and maximum was 5300 ppb-ww. About 67% of samples exceeded the NAS recommended guideline, and about 8% of samples exceeded the FDA Action Level (Table B-3).

- Mosquitofish (*Gambusia affinis*) from the Alamo River exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 1. Mean concentration of Total DDT was 1371 ppb-ww, and maximum was 1371 ppb-ww. All samples (100%) exceeded the NAS recommended guideline and the FDA Action Level (Table B-3).

- Red shiner (*Notropis lutrensis*) from the Alamo River exceeded the NAS recommended guideline and FDA Action Level for Total DDT. Total sample size was 1. Mean concentration of Total DDT was 1127 ppb-ww, and maximum was 1127 ppb-ww. All samples (100%) exceeded the NAS recommended guideline and the FDA Action Level (Table B-3).

Toxaphene, like DDT, is an organochlorine chemical with low water solubility, an affinity for soil particles, and a tendency to bioaccumulate in fish and wildlife. Toxaphene has a half-life in soil of up to 14 years (Genium 1999), has high chronic toxicity to aquatic life (USEPA, 1989) and is a recognized Proposition 65 carcinogen. USEPA canceled all registered toxaphene uses in 1983 (Ware 1991).

Tables B-4, B-5, and B-6 in Appendix B show TSM toxaphene results. Table B-4 summarizes toxaphene concentrations by fish species in the Imperial Valley. For comparison purposes, Table B-5 shows toxaphene concentrations for all monitored surface waters in the Region. Table B-6 summarizes toxaphene concentrations by fish species in the Alamo River. The NAS recommended guideline for toxaphene is 100 ppb-ww, and the FDA Action Level is 5,000 ppb-ww. A summary of the data tables follows.

- Alamo River fish samples exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 27. Mean toxaphene concentration was 571 ppb-ww, and maximum was 2200 ppb-ww. About 74% of samples exceeded the NAS recommended guideline (Table B-5).

- Fish samples from the Ag Drains exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 27. Mean toxaphene concentration was 399 ppb-ww, and maximum was 2800 ppb-ww. About 52% of samples exceeded the NAS recommended guideline (Table B-5).

- Salton Sea fish samples did not exceed the NAS recommended guideline or FDA Action Level for toxaphene. Total sample size was 21. Mean toxaphene concentration was 0 ppb-ww, and maximum was 0 ppb-ww (Table B-5).

- Colorado River fish samples did not exceed the NAS recommended guideline or FDA Action Level for toxaphene. Total sample size was 17. Mean toxaphene concentration was 0 ppb-ww, and maximum was 0 ppb-ww (Table B-5).

- Carp from the Alamo River exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 12. Mean toxaphene concentration was 447 ppb-ww, and maximum was 1100 ppb-ww. About 83% of samples exceeded the NAS recommended guideline (Table B-6).

- Channel catfish from the Alamo River exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 12. Mean toxaphene concentration was 798 ppb-ww, and maximum was 2200 ppb-ww. About 67% of samples exceeded the NAS recommended guideline (Table B-6).

- Mosquitofish from the Alamo River exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 1. Mean toxaphene concentration was 230 ppb-ww, and maximum was 230 ppb-ww. All samples (100%) exceeded the NAS recommended guideline (Table B-6).

- Red Shiner from the Alamo River exceeded the NAS recommended guideline, but not the FDA Action Level, for toxaphene. Total sample size was 1. Mean toxaphene concentration was 260 ppb-ww, and maximum was 260 ppb-ww. All samples (100%) exceeded the NAS recommended guideline (Table B-6).

- The Alamo River has the highest Total DDT concentrations (Table B-2), and one of the highest toxaphene concentrations (Table B-5), in the Region.

Ultimately, Imperial Valley's fish-eating birds are at the greatest risk from these pesticides (Bennet 1998). Resident birds typically had higher DDE concentrations than migratory species. The endangered California brown pelican, threatened bald eagle, and endangered peregrine falcon, among others, are exposed to levels of DDE that pose a high level of concern and an increased risk of adverse effects (Setmire et al. 1993). People who consume fish from the Alamo River are also at risk.

The metabolism of organochlorine pesticides (OCPs) in cells involves several mechanisms, such as oxidation and hydrolysis. OCPs have a strong tendency to penetrate cell membranes and store themselves in body fat. Due to this lipotrophic tendency, OCPs are fixed in lipid-rich cells, i.e., the central nervous system, liver, and kidneys. In these organs, they damage the functioning of important enzymes and disrupt the biochemical activity of cells (USEPA 1989). The effects of DDT on birds and aquatic organisms are well documented by USEPA, USBR, USFWS, USGS, and scientists throughout the world. Adverse effects include egg thinning, egg breakage, decreased egg productivity, decreased hatching and fledging success, decreased nesting success, chick mortality during hatching, and death (Kaloyanova and Mostafo 1991).

Sediment discharges currently laden with Total DDT and toxaphene are adversely impacting the following beneficial uses of the Alamo River: (1) Warm Freshwater Habitat; (2) Wildlife Habitat; (3) Preservation of Rare, Threatened and Endangered Species; (4) Freshwater Replenishment; and (5) Water Contact Recreation (e.g., fishing). These discharges violate the Basin Plan WQOs for sediment and suspended solids.

2.7.3 SEDIMENT AS AN IMPAIRMENT TO AQUATIC HABITAT

Sediment can significantly and adversely impact aquatic life. The Alamo River's suspended sediment load has historically been high compared to natural streams.

Sediment effects can be divided into those that occur in the water column and those that occur following sedimentation (settling of sediment from the water column). In the water column, sediment can: (1) clog fish gills, which can cause death or inhibit growth; (2) prevent successful development of fish eggs and larvae; (3) modify natural movements and migration of fish; and (4) reduce food abundance available to fish (Muncy et al, 1979).

Sedimentation may smother bottom-dwelling organisms, cover breeding areas, and smother eggs. Sediment also reduces light penetration, which in turn reduces the ability of algae to produce food and oxygen. Sedimentation causes an imbalance in stream biota by increasing bottom animal density (principally worm populations). Diversity is reduced as pollution-sensitive forms disappear (Muncy et al, 1979). Sediment indirectly affects other parameters such as temperature and dissolved oxygen, and interferes with mixing, which decreases oxygen and nutrient dispersion s to deeper layers.

2.7.4 SEDIMENT AS A TRANSPORT MECHANISM FOR NUTRIENTS

The Salton Sea also is listed on the Regional Board's 303(d) list because the Sea is impaired by nutrients. The Salton Sea has all the characteristics of a eutrophic lake, including high inputs of the nutrients nitrogen and phosphorous, intensive algal blooms, and anoxic conditions that result in fish kills and malodorous conditions (Federal Water Quality Control Administration 1970). The amount of nitrogen and phosphorous currently entering the Sea is far in excess of nutrient loadings recommended to prevent eutrophic conditions in lakes (Cagle 1998). The Alamo River, the Sea's main tributary, contributes a significant portion of these nutrients. Sediments serve as a transport media by which the insoluble forms of these nutrients enter the Ag Drains, the Alamo River and eventually the Salton Sea. Recent data indicate that insoluble forms represent about 40% of the total phosphorous and 20% of the total nitrogen that enters the Sea via the Alamo River (Holdren 2000).

2.7.5 SEDIMENT AS A VIOLATION OF NARRATIVE WATER QUALITY OBJECTIVES FOR SUSPENDED SOLIDS, SEDIMENT, AND TURBIDITY

The Alamo River carries a high sediment concentration, as indicated by total suspended solids (TSS) and turbidity measurements in downstream reaches, according to data collected by the IID, Regional Board, and U.S. Bureau of Reclamation. Data collected in the Alamo River at Garst Road Bridge, just upstream of its outlet into the Salton Sea, are summarized in Table 2.6, below. Mean TSS values for these data sources range from 300 mg/L to 436 mg/L.

Table 2.6: Data Summary: Alamo River Upstream of its Outlet to the Salton Sea

Data Source	Period of Record		TSS (mg/L)	Turbidity (NTU)
IID	1/1996-3/1998 (monthly)	mean	300	218
		maximum	430	320
		minimum	140	54
USBR	1/99-10/99 (monthly)	mean	362	NA
		maximum	480	NA
		minimum	237	NA
RWQCB 7 Trend Monitoring	2/80-1/92 (quarterly)	mean	436	214
		maximum	3040	1440
		minimum	76	63
RWQCB 7 TMDL Monitoring	12/99 and 3/00 (2 sampling events)	mean	427	283
		maximum	456	323
		minimum	399	244

The Alamo River's sediment concentrations and resulting turbid conditions are at levels which are believed to have a significant adverse impact on the aquatic environment, as discussed in Section 3.2.1. Based on the foregoing, Imperial Valley wastewater discharges into the Alamo River contain sediment concentrations that are in violation of the Basin Plan water quality objectives for suspended solids, sediment and turbidity.

3. NUMERIC TARGET

3.1 INTRODUCTION

Section 303(d)(1)(C) of the Clean Water Act states that TMDLs "shall be established at a level necessary to implement the applicable water quality control standards…." The numeric targets for the Alamo River Sedimentation/Siltation TMDL are intended to attain and maintain Basin Plan standards (CRBRWQCB 1994) and provide a basis for evaluating TMDL success . These numeric targets for the Alamo River are therefore intended to result in sediment loads and concentrations that: (1) meet the water quality objectives (Table 2.2), and (2)protect the designated beneficial uses (Table 2.1). The numeric targets presented herein are based on scientific literature, monitoring data, and professional judgment. These numeric targets are appropriate for the hydrogeological setting and for addressing the nature of the water quality impairments. Long-term monitoring data may result in future target modification.

Water column sediment indicators refer to measurements of sediment concentrations made within the water column itself. Water column sediment indicators do *not* refer to measurements of streambed sediment composition, riparian or hillslope conditions, biological and habitat conditions, or other channel condition indicators. Water column sediment indicators are used as numeric targets for this Alamo River TMDL, in accordance with EPA's *Protocol for the Development of Sediment TMDLs* (USEPA 1999b). This is due to the nature of the water quality impairments caused by suspended sediments, the relatively stable flows and average sediment concentrations, and the availability of TSS and turbidity data relative to other indicators of water quality standards attainment. Table 3.1 contains the water column indicators and corresponding numeric targets established in this TMDL.

Table 3.1: Numeric Targets for the Alamo River Sediment TMDL[a]

Sediment Indicator	Numeric Target
Total Suspended Solids (TSS)	200 milligrams/liter (mg/L) (annual average value)
Turbidity	Corresponding turbidity value, determined through statistical analyses[6]

[a] = The numeric target shall not be used for enforcement purposes.

These numeric targets apply throughout the entire U.S. length of the Alamo River from the International Boundary to the Salton Sea.

[6] Suspended solids increase water column turbidity. The relationship between turbidity and TSS is typically linear. Once this relationship is established for a waterbody, turbidity measurements can be utilized to estimate TSS, and vice versa for tailwater and agricultural returns flows in general. Once a statistically significant TSS/turbidity relationship is established for the Alamo River, the turbidity corresponding to a 200 mg/l TSS will be used as a numeric target in this TMDL.

3.2 BASIS FOR TARGET SELECTION

The most significant surface waters in the Imperial Valley (i.e., the Ag Drains and Alamo and New Rivers) are almost completely dominated by silty agricultural return flows. Therefore, there are no unimpaired or functional “reference sites” in the Imperial Valley that could be utilized to determine sediment concentrations that would be protective of beneficial uses. Other water quality criteria, such as those proposed in EPA’s *Quality Criteria for Water* (USEPA 1976, 1986), suggest limiting increases in TSS and turbidity by limiting the allowable reduction in water clarity from a seasonally-established norm for a waterbody. These criteria would not be applicable to the waters of the Imperial Valley because these waters have always had TSS and turbidity levels which have impaired beneficial uses, for the time period that data is available.

3.2.1 IMPACTS OF SUSPENDED SEDIMENTS

High levels of suspended sediments can impact an aquatic ecosystem in varying ways, depending on the type of suspended sediment and the sensitivity of particular aquatic organisms. Studies are scarce regarding suspended sediment effects on mortality or sublethal conditions of warmwater fish (Waters 1995). Warmwater streams are often muddy with silt and sandy bottoms, and are generally more turbid than coldwater streams (Waters 1995, Winger 1981). The National Academy of Sciences (NAS) recommends the following general maximum total suspended solids (TSS) concentrations to protect aquatic life (NAS 1972):

High Level of Protection	25 milligrams per liter (mg/L)
Moderate Level of Protection	80 milligrams per liter
Low Level of Protection	400 milligrams per liter

The EPA’s *Quality Criteria for Water* (USEPA 1986), also known as the “*Gold Book,”* reaffirmed the NAS’ recommended criteria. NAS recommendations were based on a literature survey of direct effects of suspended solids on the life cycle of freshwater fish, performed by the European Inland Fisheries Advisory Council (EIFAC 1964). The EIFAC literature survey also revealed that healthy fisheries are sometimes found at lower concentrations of 80 to 400 mg/L TSS. The death rate is substantially greater for fish living for long periods in waters containing TSS in excess of 200 mg/L than for fish living in cleaner water. Only poor fisheries are likely to be found in waters that normally carry greater than 400 mg/L TSS (EIFAC 1964).

3.2.2 SEDIMENT AS A TRANSPORT MECHANISM FOR INSOLUBLE PESTICIDES

Sedimentation also can affect aquatic ecosystems through the transport of nutrients and toxicants, such as heavy metals and pesticides (Muncy et el. 1979). Available evidence suggests that DDT breakdown products are still present at levels of concern in Imperial Valley soils and Alamo River sediments. However, no extensive recent data exists locally. Studies in other areas of California show that DDT breakdown products have a very long lifetime in agricultural fields with clay soils (CDFA 1985), like the soils in Imperial Valley.

Local DDE samples were collected by various parties for more than fifteen (15) years. Imperial Valley soil samples collected in 1985 contained DDE concentrations of 21 to 343 ppb-dw, with an average of 156 ppb-dw (CDFA 1985). Bottom sediment samples from the Alamo River collected in 1990 contained DDE concentrations of 18 to 64 ppb-ww, with an average of 38 ppb-ww (Setmire et al., 1990). Suspended sediment samples (that settled in a sedimentation basin) collected in 1993 and 1994 contained DDE concentrations from below the detection limit of 0.05

ppb to 111 ppb, with an average of 48 ppb (IID 1996a). Sediment samples from the Alamo River channel collected in 1996 contained DDE concentrations from below the detection limit of 0.05 ppb to 15 ppb, with an average of 6 ppb (IID 1996b).

DDE chronic concentration in waters where people consume fish or other organisms should be less than 0.00059 ppb to protect human health, according to the EPA's *National Recommended Water Quality Criteria* (USEPA 1999a). DDE concentration in the water column is estimated by multiplying DDE concentration in suspended sediment times the concentration of those sediments in the water column:

> DDE concentration in the water column = (DDE concentration in suspended sediment) x (suspended sediment concentration in the water column)

If more recent data existed, this equation also could be utilized to determine a suspended sediment level that would meet EPA criteria for DDE within the water column. However, utilizing available data, the equation indicates that significant reductions in the Alamo River's TSS concentrations are needed to meet the EPA chronic criterion for DDE.

If high concentrations of suspended sediments entering the Alamo River are reduced, then a net reduction of insoluble pesticides will occur in the River itself, in the Salton Sea, in the Sea's delta with the River, and in aquatic organisms living there. Alamo River pesticide concentrations will be monitored. Numeric targets in this TMDL will be adjusted accordingly if further reductions are needed to meet water quality objectives.

3.2.3 SEDIMENT AS A TRANSPORT MECHANISM FOR NUTRIENTS

Sediments serve as a transport mechanism by which a significant portion of the nutrients nitrogen and phosphorous enter the Ag Drains, Alamo River and eventually the Salton Sea. Organic and condensed phosphates, as well as organic nitrogen, bind to suspended sediments in agricultural tailwater.

Attainment of Alamo River numeric targets should also result in significant reduction of nutrient loadings to the Salton Sea. The Sea is currently listed on the Regional Board's 303(d) list as impaired by nutrients, and scheduled for the development of a nutrient TMDL. Until that TMDL is completed, nutrient loading reductions to the Sea will not be known. However, progress towards attaining sedimentation reductions for Imperial Valley waterbodies equates to progress towards attaining nutrient reductions for the Salton Sea.

3.3 NUMERIC TARGETS

Numeric targets set forth in this TMDL are based on reasonable levels for protecting aquatic life from the direct effects of suspended sediments in the aquatic environment. Numeric targets were *not* based on: current levels of local DDE and other insoluble pesticides in the water column of the Ag Drains and Alamo River, or (2) nutrient loading reductions needed for the Salton Sea.

The numeric target set forth in this TMDL is an annual average TSS concentration of 200 mg/L, and a corresponding annual average turbidity level (based on a statistically established TSS-turbidity relationship for the Alamo River). The target takes into account that the Alamo is a warmwater river, and that local aquatic organism populations have developed in conjunction with high sediment loads. Achieving this target should result in the Alamo River being unimpaired by sedimentation/siltation.

This target represents significant reductions in current TSS and turbidity levels, as explained below, and will take several years to meet. Numeric targets will be refined as necessary, as discussed in Section 7 of this TMDL Report.

3.4 EXISTING CONDITIONS

Table 3.2 compares the most recent TSS measurements at the Alamo River outlet with the numeric target for this TMDL. (Regional Board staff performed TSS measurements in December 1999 and March 2000, and the U.S. Bureau of Reclamation collected samples every month in 1999 (RWQCB, 12/99 and 3/00 unpublished data; U.S. Bureau of Reclamation, 1999). A 44 to 50% TSS reduction is needed to meet the numeric targets at the Alamo River delta outlet to the Salton Sea.

TABLE 3.2: Comparison of Existing Conditions to Numeric Target

Location:	TSS (mg/L)	Target TSS (mg/L)	Reduction Needed
Alamo River at Garst Road Bridge	377*	200	47%

*Mean concentration based on all available data from 1980-2000 from CRWQCB 7, IID, and USBR.

As discussed in the Source Analysis (Section 4), the Alamo River suspended sediment concentrations tend to increase in the downstream direction (Huston et al. 2000). Therefore, the outlet of the Alamo River to the Salton Sea is the location with the greatest need of reduction in TSS and turbidity.

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4. SOURCE ANALYSIS

4.1 INTRODUCTION

The purpose of the source analysis is to identify and quantify the sources contributing sediment to the Alamo River. Due to the arid climate in the Imperial Valley, sedimentation processes in the Alamo River watershed are mainly a function of geology, topography, and land uses. Over 90% of the land in Alamo River watershed is dedicated to highly productive irrigated agriculture. While the average annual rainfall in the Imperial Valley is only about 3 inches, the land within the Alamo River watershed receives over 1.5 million acre-feet in irrigation water annually, or an average of about 5 feet of water per year.

4.2 SOURCES OF SEDIMENT

The most significant sources of the sediments in the Alamo River are agricultural discharges. Other sediment sources of concern are the IID's drain maintenance operations—namely dredging and vegetation removal. Drain dredging, typically done with a heavy-duty backhoe (see Figure 4.1, below), results in short-term extreme increases in turbidity because the operation re-suspends bed bottom sediment and erodes the drain sidewalls and bed bottom. Vegetation removal results in long-term increases in turbidity as the vegetation removed from the banks and bed of the drain had a sediment binding effect. Also, as the vegetation is being removed, the drain sidewalls and bed bottom are eroded banks and bed sediment is also re-suspended. Minor sources of sediment and suspended solids in the Alamo River are in-stream erosion and wind deposition. Negligible sources of sediments to the Alamo River are stormwater and urban runoff, and the point source discharges to the Alamo River (eight wastewater treatment plants, six power plants, and a fish hatchery).

Figure 4.1: IID Drain Dredging Operation (CRWQCB 9/2000)

Sediment sources can be classified as either natural or originating from human activities, and can be further classified as either point sources (e.g., wastewater treatment plants, which have a single point of origin), or nonpoint sources (e.g., agricultural discharges and stormwater runoff). Figure 4.2, below, illustrates the sources of sediment to the Alamo River as they fit into these classifications. For the purpose of this analysis, the contribution to the Alamo River from Mexico at the International Boundary is treated as a nonpoint source of pollution from human activities.

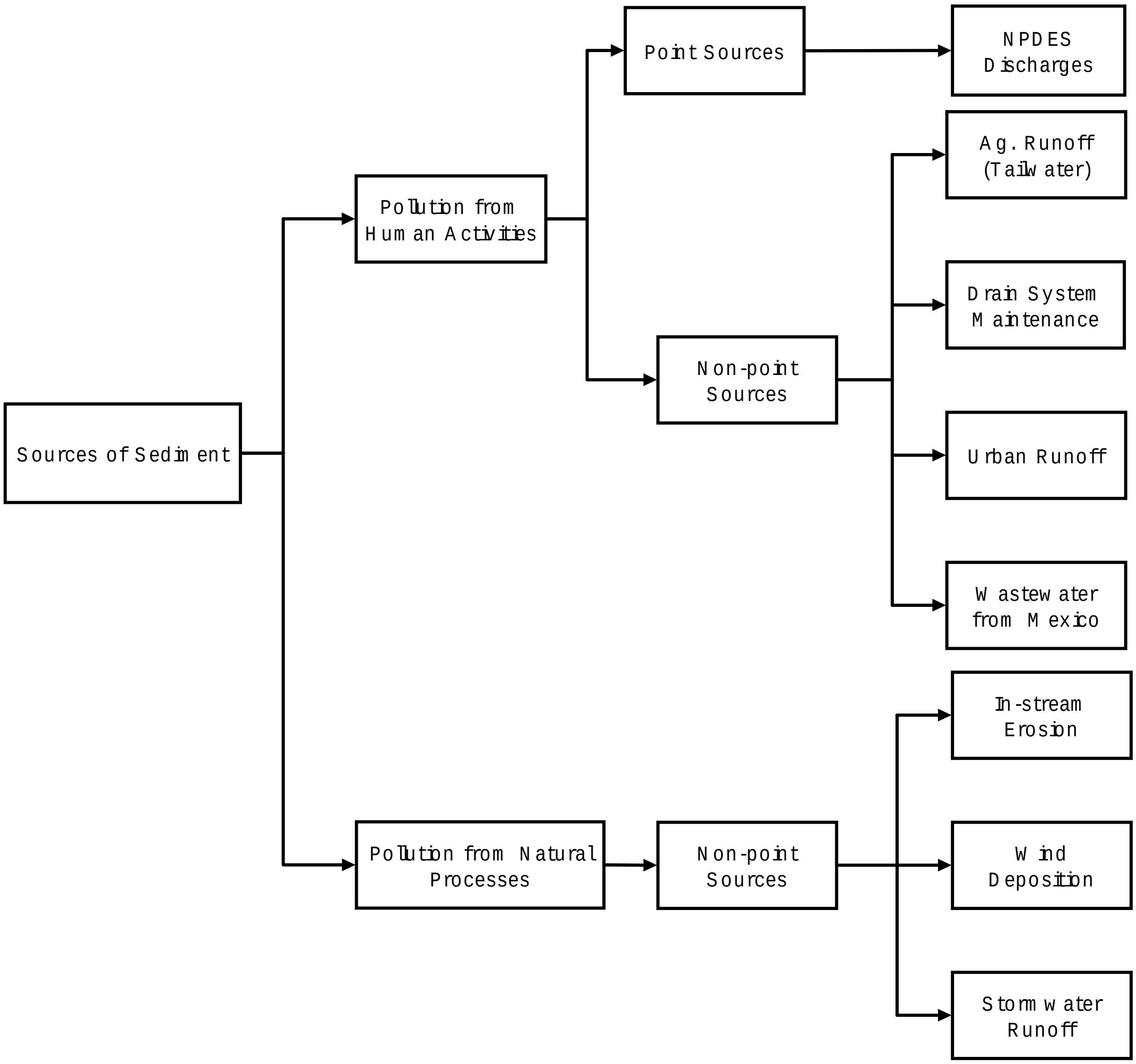

Figure 4.2: Sources of Sediment of the Alamo River

4.2.1 AGRICULTURAL RETURN FLOWS

4.2.1.1 Components of Agricultural Return Flows

Over 96% of the flow in the Alamo River originates from irrigated agriculture. Typical irrigation practices within the Alamo River watershed involve the use of flood irrigation. Water from an irrigation canal is released at the head end of the field, and is allowed to flow with the gradient toward the tail end of the field. The general composition, by sources of water in the Ag Drains, is shown in Table 4.1, below. An operational spill is the quantity of fresh water that reaches the terminal end of an irrigation canal, but is not applied to the fields, and therefore must be diverted into a drainage ditch. Tailwater is irrigation water that does not percolate into the soil, and exits the lower end of the field into the drain. Tailwater tends to erode fields and thus acquire silt and sediments as it crosses and exits a field. Tilewater is water that has percolated through the soil, but is not absorbed by crops. Tilewater flushes salts from the soil. This highly saline water accumulates in tile lines beneath the fields, wherein it is transported to drains by gravity flow or a sump system. Seepage denotes subsurface water that enters a drain due to a hydraulic gradient resulting primarily from loosing irrigation canals. Of these sources, tailwater is the primary source of sediments. Seepage, tilewater, and operational spills consist of relatively sediment free water, and thus serve to effectively dilute the sediment concentrations found in tailwater.

Table 4.1: 1987-1996 Average Annual NPS Discharges to the New River, Alamo River, and Imperial Valley Drains by Source

Source	Acre-feet	Percent
Operational Spill	123,018	12
Tailwater	479,661	48
Tilewater	261,278	26
Seepage	128,165	13
Total	992,122	100

Source: Jenson, M.E., Walter, I.H., June 1997

4.2.1.2 On-Field Erosion

The rates of irrigation-induced erosion on agricultural fields in the Imperial Valley, and the resulting sediment concentrations in tailwater, are dependent on many variables, including: the irrigation methods (including rate, uniformity and method of water application and drainage), field size, field gradient (downslope and sideslope), crop type and phase in the growing cycle, soil type, tillage practices, characteristics of the tailwater ditch and drop structure, and effectiveness of any sediment control management practices utilized. A variety of crops are grown in the Imperial Valley, each requiring various cultivation techniques and irrigation water quantities. Crop data for 1998 are shown in Table C-1 in Appendix C. An effect of the numerous crops being grown in the Imperial Valley is that irrigation and irrigation-induced erosion occur year round in the Alamo River watershed, although at varying magnitudes.

The shearing force that irrigation water exerts on the soils of the field causes irrigation-induced erosion on an agricultural field. The total shearing force applied to a field will increase with increases in the velocity of the irrigation water, the depth of the irrigation water, and the total area and duration of contact between the soil and the irrigation water. The amount of sediment that will be detached and transported from a field by a given irrigation-induced shearing force is also affected by the erosiveness of the soil types in the field, the condition of the soil structure in the field, and the presence, condition, and type of vegetation within different areas of the field.

The Imperial Irrigation District's irrigation and drainage system is described in Section 2.5.1. In general, for an Imperial Valley field, the highest water velocities and least vegetation are found at the bottom of the field, especially in the tailwater ditch. These factors make tailwater ditch erosion a major source of the sediment contributed to the drainage system. In addition, erosion at the bottom of the field tends to increase the slope of the field, therefore increasing velocity, and thus erosion, in the entire field. Other areas where erosion commonly occurs on an irrigated field include the drops from the furrows into the tailwater ditch, within the furrows themselves, and in the head ditch where water enters the field.

4.2.1.3 Drain Erosion and Dredging

Over 900 miles of Ag Drains receive drainage from fields in the Alamo River watershed and discharge both water and sediments to the Alamo River. Over one third of the watershed is drained by five (5) major drains that drain directly into the Alamo River, each of which receive drainage from over ten tributary drains. These are the Rose, Holtville, Central, South Central and Verde drains. The remainder of the watershed is drained by seventy-one (71) minor drains which drain directly to the Alamo River, each of which are usually fed by less than two tributary drains. Factors effecting the erosion in the Ag Drains include conditions and soils of the channel material; drain slope, channel geometry, bank vegetation, flow, and dredging practices. The Ag Drains are relatively straight, trapezoidal, and unlined. The bottom and sidewall materials of the drains are the Imperial Valley soils generally described in Section 2.6. As channel material, these soils can generally be referred to as cohesive sediments due to their high silt and clay content. The amount of vegetation present on the channel walls varies from no vegetation to a somewhat dense vegetation of grasses and shrubs. Vegetation is also periodically removed from drain banks during IID dredging operations and/or during operations conducted with the sole purpose of removing vegetation. In general, water velocities and over 250 concrete weirs or drop structures in the Ag Drains effectively limit downward erosion within these drains. Erosion of the channel banks does occur within these drains, however.

Due to the sediment loads they receive from agricultural fields, many of the Ag Drains require periodic dredging to maintain adequate drainage. Dredging operations remove about 475,000 tons of sediment annually from the Ag Drains in the Alamo River watershed (IID 2000). The dredging process also suspends large quantities of sediment and removes vegetation from the drain making the drains more susceptible to erosion, and is thus a significant source of the suspended sediments to the Alamo River.

4.2.2 IN-STREAM EROSION

The Alamo River travels approximately 60 river miles through the Imperial Valley. Factors effecting the erosion in the Alamo River include its slope, channel geometry, the condition and composition of its channel material, bank vegetation, aquatic vegetation (particularly in the upper reaches), and the rate of flow. The Alamo River flows perennially, with flows at the outlet ranging from a maximum of about 1700 cfs to a minimum of about 350 cfs, and averaging about 900 cfs (about 650,000 AFY) based on flow data from 1994 through 1999 (Huston et al. 2000). 13 weirs or drop structures present in its channel, thus making the river a relatively slow moving, stable river, effectively limit water velocities and downward erosion rates within the Alamo River. These drop structures effectively reduce the slope of the Alamo River to about 2.9-feet per river mile, or about 0.05% (Huston et al. 2000). Researchers from the University of California at Davis estimated the velocity within the entire U. S. length of the Alamo River in March 1999 as less than 3 feet per second (Huston et. al, 2000). The channel material of the Alamo River is much like that of the Ag Drains—sediments with a significant silt and clay content (Zimmerman 1981), which can generally be defined as cohesive sediments. The Alamo River banks are densely vegetated with shrubs, grasses, and trees, the most common vegetation being salt cedar.

4.2.3 POINT SOURCE (NPDES) FACILITIES

Currently, there are eight (8) Wastewater Treatment Plants (WWTPs) permitted to discharge treated domestic wastewater into drains tributary to the Alamo River. There are also six (6) power-generating facilities and one (1) grass-carp hatchery discharging into the tributaries of the Alamo. All of these WWTPs and facilities have NPDES permits and are required to submit self-monitoring data documenting the quality and volume of their effluent. As described below, analysis of these data indicates that point sources are an insignificant source of the suspended solids in the Alamo River for the main purpose of this TMDL. Further, the suspended solids from these sources are generally organic in nature (i.e., biodegradable).

4.2.4 WASTEWATER FROM MEXICO

Pursuant to an agreement between the U.S. and Mexico, a weir was constructed in 1997 at the Alamo River in Mexico, about one hundred feet upstream of the International Boundary with the intent of preventing dry weather flows from Mexico from ending up in the Alamo River in the U.S. Although the weir is currently in place, lack of operation and maintenance of drainage channels upstream of it has caused the water, mostly agricultural return flows, to continue to flow into the U.S. As described below, the analysis of the available data indicates that the flows from Mexico are a minor source of sediment or other suspended solids in the Alamo River.

4.2.5 STORMWATER RUNOFF

Stormwater runoff refers to surface runoff entering the Alamo River or its tributaries due to precipitation events within the watershed. Stormwater runoff transports sediments into the Alamo River and its tributaries. As described in the analysis below, due to the extremely arid climate of the Imperial Valley, stormwater runoff is not believed to be a significant source of sediment to the Alamo River.

4.2.6 URBAN RUNOFF

Urban runoff refers to water originating from human activities from city streets and adjacent domestic or commercial properties. This runoff can carry suspended solids into receiving waters. As described below, due to the arid climate and small population of the watershed, the loading of sediments and other suspended solids from urban runoff is considered negligible.

4.3 SOURCE ANALYSIS METHODOLOGY

4.3.1 SUMMARY OF ANALYSIS

The source analysis is based on existing data and was conducted by identifying and quantifying the natural and management related sources and processes contributing to the sediment loading of the Alamo River. Where major data gaps existed, field monitoring was conducted to address these deficiencies. The available data for the watershed, and the methods utilized to quantify the sediment loads being contributed by the identified processes and sources are described below.

<u>Analysis for Point Sources</u>

- The monthly suspended solids load from each point source of pollution (i.e., NPDES facilities) into the minor drains was calculated by multiplying the reported monthly effluent flow from the facility times the reported monthly effluent TSS concentration from the facility.[7]

Analysis for Nonpoint Sources

- The monthly suspended sediment load in the Alamo River at the International Boundary with Mexico was calculated by multiplying monthly measured average TSS concentrations by total monthly flow;
- Monthly flow data for the minor drains was estimated from the monthly irrigation water deliveries for the areas being served by the drains;
- Missing monthly flow data for the major drains was estimated using statistical analyses of existing major drains flow data and the irrigation delivery data for the areas being served by the major drains;
- The monthly suspended sediment load contribution from each of the minor drains to the Alamo River was estimated by multiplying the estimated monthly flow of each minor drain times the average TSS concentration for the minor drains;
- The monthly suspended sediment load contribution from each of the major drains to the Alamo River was estimated by multiplying the flow of the drain times the TSS concentration available for the major drains;
- The potential relative contribution from drain dredging operations was estimated by using TSS monitoring data collected by Regional Board staff upstream and downstream of a dredging operation and by using flow data provided by IID;
- An estimate of the load due to stormwater runoff from urban and farmland areas in the Alamo River watershed was calculated using actual recorded precipitation data from 1994 through 1999 for the area and using a literature value for TSS of 150 mg/L for urban runoff (Terrene Institute and USEPA, 1994); and
- A mass balance has estimated the potential cumulative loading caused by in-stream erosion and wind deposition in the drains.

Because of the limited available data, the source analysis must be viewed as an estimate of loading conditions for both the drains and the Alamo River—an estimate that must be refined through on-going data acquisition and monitoring. The following paragraphs detail the analysis, data available for the analysis, methodology used for the analysis, and the assumptions used herein.

[7] It is recognized that the TSS from point sources is not a concern within the context of this TMDL. The analysis of point source loading was conducted only to characterize the relative contribution by other nonpoint sources of pollution using a mass balance approach because the data available for estimating the sediment load in the river are reported as "suspended solids."

4.3.2 DATA AVAILABLE FOR SOURCE ANALYSIS

4.3.2.1 Description of Data Sources

The Imperial Irrigation District (IID) maintains extensive databases on irrigation deliveries, and drain flows, and also has considerable data on the quality of both irrigation and drain water. During the period spanning November 16, 1999 to March 28, 2000, Regional Board staff mailed several requests to IID asking for all available drain flow and water quality data for 1994 through 1999, as well as irrigation delivery data and other information relevant to this TMDL. Copies of all of these data requests are located in Appendix D. All of the available data has been received according to IID.

In January 2000, IID provided a database with drain, canal, and river flow data to Regional Board staff to facilitate development of the sediment TMDL. Typically, IID measures real time flow by using a weir in combination with a measuring/recording device. IID obtains flow data for the Alamo River at the Outlet to the Salton Sea through the USGS, which interpolates flow for days for which gauged flow data is unavailable. There are instances within the data set for various sampling sites wherein flow data for specific dates are missing. Because these instances are relatively few, the overall flow data is assumed to be accurate, within plus or minus 20%[8], the accuracy of the flow metering instrumentation.

IID has also provided TSS and turbidity data collected pursuant to its Drain Water Quality Improvement Plan (DWQIP) as mentioned. The DWQIP sampling protocols for TSS call for collection of grab samples. A review of the plan indicates that the sampling procedure and lab analysis methods are acceptable for the purpose of this source analysis.

The USGS has two (2) sampling stations along the Alamo River at which flow and TSS are measured. One station is near Calipatria, and the other station is near Niland. The Niland station data are used for Alamo River at the Outlet. Figure C-1 in Appendix C shows the locations of the gauging stations. Daily recorded precipitation data are also available for the Brawley, El Centro, and Imperial areas from 1994 through 1999.

Regional Board staff conducted sampling events in December 7-10, 1999 and March 3, 2000. The purpose of the sampling was to measure TSS and turbidity in the Alamo River, the main drains, and several randomly chosen minor drains for use in the development and implementation of this TMDL. The December 1999 sampling event included eight (8) sampling stations located on the Alamo River, one (1) on the outlet of each of the five (5) major drains, and one (1) on the outlet of thirteen (13) minor drains for a total of twenty-six (26) sampling stations. For the March 2000 event, the outlets of ten (10) randomly chosen minor drains were sampled. Review of the sampling results indicates a strong linear correlation (R^2 = 0.89) of TSS to turbidity (see Figure C-2 in Appendix C.

Regional Board staff monitored TSS concentrations in the Warren Drain during a dredging operation on February 8, 2000. The purpose of the monitoring was to obtain an understanding of the potential increase in TSS caused by the operation. TSS sampling included both upstream and downstream sample collection. The results indicate that the upstream TSS

[8] Accuracy reported by Mr. Elston Grubaugh, Superintendent of Water Resources during a meeting with Regional Board staff at IID on March 15, 2000.

concentration was less than 30 mg/L, while 500 feet downstream of the dredging operation the TSS concentrations were measured over 5,000 mg/L.

All point source facilities in the watershed are required under their NPDES permits to submit regular reports to the Regional Board containing data on both the volume and quality of their effluents.

Regional Board staff conducted ambient water quality sampling of the Alamo River and two of its major tributary drains (Holtville and Central Drain) from 1980 through 1994 under the Regional Board's Trend Monitoring program. The parameters analyzed include both TSS and turbidity.

4.3.2.2 Summary of Available Data

In summary, the following data for the Alamo River watershed are available:

FLOW DATA:

- Point Source (NPDES) Facilities – Daily flow data for NPDES facilities discharging into the Alamo River watershed are available in the Regional Board's files. Data and calculations encompassing 1994-1999 are presented in Table C-2 in Appendix C.

- Alamo River Outlet – Monthly flow data spanning 1994-1999 has been obtained from the IID for the Alamo River at the outlet.

- Alamo River at the International Boundary – Monthly flow data at the international boundary has been provided by IID for the 1994-1999 period.

- Major Drains – IID has provided January 1994 through September 1999 monthly flow data for all five (5) major drains. This dataset contains relatively few missing data points. Missing major drain flow data is addressed in Section 4.3.2.1.

- Minor Drains – January 1994 through November 1999 monthly flow data for the gauged minor drains have also been obtained from IID. IID gauged flows in a total of seventeen (17) minor drains out of the seventy-one (71) total during this period. However, most drains were gauged for only a fraction of that period, with only four (4) drains (Marigold, Mayflower, Narcissus, and Standard Drains) containing a complete or near complete record for the entire period. Minor drain flows calculation methods are contained in Section 4.3.2.1.

- Irrigation Deliveries – IID provided a database with the records of the daily January 1994–September 1999 irrigation water deliveries for the watershed. Database fields include canal, drain, drain prefix, drain suffix, and delivery date, and delivery quantity in acre-feet.

- Daily recorded precipitation data are also available for the Brawley, El Centro, and Imperial areas from 1994 through 1999.

TSS AND TURBIDITY DATA:

- NPDES Facilities – Complete records of NPDES effluent TSS concentrations are available from the Regional Board files. Data spanning from 1994 through 1999 are presented in Table C-2 in the Appendix C.

- Alamo River Outlet – A TSS and turbidity dataset from the subject period for the Alamo River at the outlet with the Salton Sea was created by combining data from IID, Regional Board Trend Monitoring Data, and data from the Regional Board staff December 1999 sampling event. The Regional Board's Trend Monitoring Data covers quarterly sampling from January 1980 through May 1993. TSS data for the outlet is displayed in Table C-3 in Appendix C.

- Alamo River at the International Boundary – Monthly TSS and turbidity data for the International Boundary is available from the Regional Board Trend Monitoring Data. The data is shown in Table C-4 in Appendix C.

- Major Drain – IID provided monthly TSS and turbidity data encompassing January 1996 through March 1998 for the Holtville and South Central Drains. Although sparse, the Board's Trend Monitoring data encompass January 1980 through May 1993 TSS and turbidity data for the Holtville and Central Drains. TSS and turbidity data for all five (5) drains is also available for the sampling events conducted by Regional Board staff in December 1999 and March 2000. The only available data for the Verde and Rose Drains is from the December and March sampling events. Table C-5 in Appendix C shows these major drain data.

- Minor Drain – TSS and turbidity data for the minor drains were acquired during the December 1999 and March 2000 Regional Board staff sampling events, which is displayed in Table C-6 in Appendix C.

- Drain Maintenance Operations **-** In order to start documenting the effects of drain maintenance operations on suspended sediment, in particular drain dredging, Regional Board staff monitored TSS and turbidity during a dredging event on February 8, 2000. A summary of the results is depicted in Table C-7 in Appendix C. However, Regional Board staff recognizes that the project may result in short-term impacts, but that does not account for other drain operations that may have similar or more severe, long-term water quality impacts. Therefore, there is a need to develop and implement a more comprehensive monitoring program to quantify the impacts from drain maintenance operations.

4.4 SOURCE ANALYSIS FOR POINT SOURCES

The Clean Water Act defines a point source as "…any discernible, confined, and discrete conveyance, including but not limited to, any pipe, ditch, channel, tunnel, conduit, well, discrete fissure, container, rolling stock, concentrated animal feeding operation, landfill leachate collection system, vessel or other floating craft from which pollutants are or may be discharged. This term does not include return flows from irrigated agriculture or agricultural storm water runoff." The point source TSS loading into the River occurs via the drains. An analysis of the contribution of the point sources to the drains is presented herein only to estimate, by process of elimination, the relative contribution by nonpoint sources (e.g., tailwater and in-stream erosion).

There are eight (8) Wastewater Treatment Plants (WWTPs), six (6) power generating facilities and one (1) grass-carp hatchery, which discharge effluent into drains tributary to the Alamo River. The TSS loading from each of these facilities was estimated using the self monitoring data for each facility by multiplying the average (1994-1999) TSS concentration for each month by the average (1994-1999) flow for that month. The results indicate that the "sediment load" from all of these facilities is negligible compared to the overall sediment loading of the Alamo River of approximately 330,000 tons per year. In fact, the actual sediment contribution from these facilities is insignificant because the TSS from the facilities is mainly comprised of biodegradable matter, and the sediment of concern here is primarily sediment laden with insoluble pesticides. The TSS loading from these point sources is a concern from the standpoint of nutrient delivery, however. Facility names and average yearly discharge flow and TSS data for 1994-1999 are shown in Table 4.2, below. Monthly flow and TSS data are presented in Table C-2 in Appendix C.

Table 4.2: Average Annual TSS Loading from NPDES Facilities (1994-1999)[9]

Discharger	Discharge Location	Flow (Acre-ft/yr)	"Sediment Load" (tons/yr)	% of Drain Flow	% of Alamo River Flow at the Outlet
City of Calipatria	G Drain	1011.5	41.5	6.9%	0.16%
City of El Centro	Central Drain	5005.2	90.3	6.9%	0.78%
City of Holtville WWTP	Pear (Palmetto) Drain	607.5	14.8	0.1%	0.09%
City of Imperial MWTP	Rose Drain	669.4	4.3	1.0%	0.10%
Heber Public Utilities District	Central Drain	435.7	4.5	0.6%	0.07%
Imperial Community College District	Central Drain	35.8	0.3	0.0%	0.01%
Sunset Mutual Water Co	Central Drain	41.3	0.4	0.1%	0.01%
Country Life MHP	Central Drain	48.0	0.3	0.07%	0.01%
Heber Geothermal	Central Drain	2941.0	19.1	4.06%	0.46%
El Centro Steam Plant	Central Drain	224.1	3.0	0.31%	0.03%
New Charleston Power Plant	Rose Drain	16.2	3.1	0.02%	0.00%
IID Grass Carp Hatchery	Central Drain	115.6	13.2	0.16%	0.02%
Star Group 1A	Holtville Main Drain	399.2	20.5	0.49%	0.06%
Rockwood Gas Turbine Station		0.0	0.0		0.00%
Imperial Valley Resources		0.0	0.0		0.00%

4.5 SOURCE ANALYSIS FOR NONPOINT SOURCES

Nonpoint sources, as defined by the USEPA, are "diffuse pollution sources (i.e. without a single point of origin or not introduced into a receiving stream from a specific outlet)." Generally, these encompass discharges that are not classified as point sources. Although a point source includes discharges from pipes and ditches, agricultural return flows discharged through pipes are exempted from the point source classification. For the purpose of this TMDL, agricultural return flows (i.e., tailwater and tilewater); wind deposition, in-stream erosion, stormwater runoff, and urban runoff are considered nonpoint sources. Also, the sediment contribution from Mexico at the International Boundary is treated as a single nonpoint source contribution, even though it is the resulting mix of wastes from point and nonpoint sources in Mexico.

4.5.1 ALAMO RIVER AT THE INTERNATIONAL BORDER ANALYSIS

The 1994-1999 average flow of the Alamo River at the U.S./Mexico border, as measured by IID, is 1,549 acre-feet (AF) per year. In calculating Mexico's contribution to the sediment load of the Alamo River, monthly flow and TSS values, given in acre-feet per month and milligrams per liter, respectively, are multiplied and then converted to tons per month by multiplying the results by a

[9] Calculations based on actual self-monitoring report effluent data for each NPDES facility.

conversion factor of 0.0013597. A sample calculation is shown in Figure 4.3. Detailed calculations are presented in Table C-8 in Appendix C. Yearly flow and relative TSS contributions from Mexico to the Alamo River at the international boundary are shown in Table 4.3.

- Monthly Loading = Monthly Flow x Average Monthly TSS

$$\text{Jan 1999 Loading (tons)} = 142.4\ \text{acre-ft} \times 50.9\frac{mg}{L} \times 0.0013597\frac{L * tons}{acre\text{-}ft * mg} = 9.86\ tons$$

Figure 4.3: Sample Calculation – Sediment Load

Table 4.3: International Boundary Contribution

	Flow Volume (AF/yr)	Loading (tons/yr)
1994	1744.0	180.1
1995	1233.0	137.2
1996	995.6	100.3
1997	1564.0	153.4
1998	1443.1	140.5
1999	1633.8	162.8
Average	1435.11435.6	145.7

4.5.2 AGRICULTURAL RETURN FLOWS ANALYSIS

To calculate the sediment loading from agricultural runoff, it was necessary to estimate the flows for essentially all the minor drains from 1994 through 1999. It was also necessary to estimate the missing monthly flow records for the major drains for the same period. Further, it was crucial to assemble a data set of TSS for both major and minor drains. The following sections describe the procedures used for the flow estimations and the data set.

4.5.2.1 Flow Estimation and Assumptions

Point and nonpoint source flow and sediment data gathered from January 1994 through March 2000 were analyzed for the source analysis. Because of the limited available flow data for the minor drains and data gaps for the major drains, a water balance coupled with statistical inferences are used herein to estimate (1) the ungauged monthly flows discharged by the major drains into the River, and (2) the monthly flows discharged by each of the minor drains for the referenced period. Estimates for the minor drains are based on IID water irrigation delivery data. Estimates for the missing monthly flow records for the major drains are also based on IID water delivery records and statistical analyses of the available flow data for the major drains. Similarly, a mass balance is used to estimate the suspended sediment contribution from each drain to the Alamo River for the subject period. The major assumptions in this source analysis are as follows:

- The return flows in a particular drain are proportional to the irrigation water deliveries to the particular area served by the drain (i.e., to the water delivered via the major irrigation canals); this relationship was found to be reasonably accurate for the gauged drains, where both water deliveries and return flow information were available, and therefore similar water delivery to outflow relationships were assumed for the ungauged drains.

- TSS concentrations in the major drains are comparable; this assumption was based on the similarities of the geology, topography, and water and land uses within the different "drainsheds"; and general channel characteristics of the major drains.
- TSS concentrations in minor drains are comparable; this assumption was based on the similarities of the geology, topography, and water and land uses within the different "drainsheds", and general channel characteristics of the minor drains.
- Most of the sediment re-suspended by dredging operations does not settle out within the drain and, thus, end up in the Alamo River; this assumption was based on the small particle sizes, silt and clay, found in the Imperial Valley soils that fill the drains prior to dredging operations.

The first step in the analysis was to identify (1) all drains discharging into the River, separating minor drains from major drains and their tributaries, as discussed previously, and (2) the corresponding major and minor irrigation canals. The available drain flow data and irrigation water delivery data were then analyzed on a monthly basis for each of the major and minor drains and were evaluated to determine whether they were normally distributed based on their coefficient of variance (CV) (i.e., checked to use appropriate statistical procedures). The data were also analyzed for potential outliers using Chauvinet's Criterion, as recommended in literature (Kennedy and Neville, 1986). If a particular monthly flow/delivery value for any particular drain/canal was identified as an outlier, all discharges/deliveries for that drain/canal were reviewed to determine whether the database contained a complete record for the month. If the record appeared to be incomplete as indicated by no data entries for any given number of days, then the value was disregarded for analysis.

Major Drain Flow Estimations: Two methods are used to address flow data gaps in the major drains. The first method estimates the missing monthly flows for the five major drains from the available drain flow data (see Table C-9 in Appendix C) and irrigation delivery data (see Table C-10 in Appendix C). Specifically, the ratios of drain flow to irrigation delivery for each month for each drain and corresponding canal were calculated for all months except the missing months. Then, the mean value, standard deviation (STDEV), and CV for each of the months for the subject period were calculated. The ratios and statistics are shown in Table C-11, Appendix C. The mean ratios multiplied by the major canal irrigation delivery for the missing month were used to estimate the corresponding missing flow values for that month for each drain. A sample calculation for a ratio and for a missing drain flow value for the Central Drain is illustrated in Figure 4.4, below. Detailed calculations are shown in Table C-12 in Appendix C.

$$\text{May 1998 ratio} = \frac{\text{May 1998 Drain Flow}}{\text{May 1998 Irrigation Flow}} = \frac{7{,}279.6 \text{ acre-ft}}{19{,}923.5 \text{ acre-ft}} = 0.3654$$

$$\textbf{May 1995 Data Gap} = \textbf{Average}_{94\text{-}99}\textbf{ May ratio x May}_{95}\textbf{ Deliveries}$$
$$= 0.3654 \times 19695 \text{ acre-ft} = 7{,}183 \text{ acre-ft}$$

Figure 4.4: Sample Ratio and Flow Calculation for Central Drain Flow

As of the date of this analysis, irrigation delivery data for November and December 1999 were not available. Therefore, the second method uses the monthly average values for the subject period (i.e., the 6-year average for November and December) to estimate the corresponding flow data for those months for the major drains.

Minor Drain Flow Estimations: The flow estimates for the minor drains are based on (1) the assumption that the monthly flow in a particular minor drain is proportional to the monthly amount of irrigation water delivered to the area served by the drain via the parallel minor canal, and (2) a water balance for the gauged flows for the Alamo River and all drains and the estimated flows for the major drains. The water balance was used to determine the overall monthly flow contribution from the minor drains (i.e., the "unaccounted" or "undistributed" flow in the Alamo River) by adding the monthly gauged drain flows to the monthly Alamo River flows at the International Border and subtracting that result from the monthly Alamo River Outlet flow. The water balance is shown in Table C-13 in Appendix C. Next, the monthly irrigation deliveries for each minor canal and the total irrigation water delivered to the minor drains for each month were calculated for the subject period using the irrigation data provided by the IID. Individual monthly irrigation deliveries for the drains and the total irrigation deliveries for the drains are displayed in Table C-14 and C-15 in Appendix C, respectively. These data were then reviewed to evaluate whether they were normally distributed and to determine if the data contained potential outliers (see Table C-16 in Appendix C). Then, the monthly ratios of irrigation deliveries for a particular minor canal to the total amount of irrigation deliveries to all minor canals for corresponding months were determined. The ratios are shown in Table C-17 in Appendix C. The minor drain flow for a particular month was then calculated by multiplying that month's ratio for the minor canal times the "unaccounted" flow in the Alamo River for that month. The process was repeated for every minor drain, for every ungauged month. Minor drain calculations and flows are presented in Table C-18 and C-19 in Appendix C. A sample calculation for the monthly flow in the "D" Drain for January 1999 is presented in Figure 4.5, below.

- Undistributed Alamo River Flows =

$$\text{Alamo Outlet Flows - Alamo Inlet Flows - Gauged Drain Flows}$$
$$= 44{,}636.7 - 21{,}452.8 - 142.4 = 23{,}000 \text{ acre} \cdot \text{ft}$$

- $\text{January 1999 Ratio} = \dfrac{\text{Jan 1999 Irrigation Delivery to the "D" Drain}}{\text{Jan 1999 Total Irrigation Deliveries to the Minor Canals}}$

$$\text{D Drain Ratio (Jan 1999)} = \frac{213.8 \text{ acre} \cdot \text{ft}}{39{,}137.0 \text{ acre} \cdot \text{ft}} = 0.005463$$

- Monthly Ungauged Drain Flow = Average Monthly Ratio x Monthly Undistributed Alamo River Flow

$$\text{D Drain Flow (Jan 1999)} = 0.005463 \text{ x } 23{,}000 \text{ acre} \cdot \text{ft} = 126 \text{ acre} \cdot \text{ft}$$

Figure 4.5: Sample Calculation for Estimating the "D" Drain January 1999 Flow

As in the case with the major drains, average monthly flow data from 1994-1999 for the minor drains were used for the October, November, and December 1999 flows.

4.5.2.2 *Estimation of TSS Concentrations in the Drains*

The TSS concentration data used in the analysis of main drain loading are a combination of the TSS data collected by IID pursuant to its DWQIP, the Regional Board Trend Monitoring data, and the Regional Board's sampling events in December 1999 and March 2000. The data were combined into a single data set, and the average monthly concentration from the data set was determined. The overall monthly average was then applied to each major drain. Detailed calculations are shown in Table C-5 in Appendix C. TSS data for minor drain analysis are a combination of the December 1999 and March 2000 Regional Board sampling events, as illustrated in Table C-6 in Appendix C.

4.5.2.3 *Major Drain Loading Analysis*

The five (5) major drains provide drainage for a major portion of the Alamo River watershed. The main processes affecting the sediment load in the major drains are field erosion, in-stream erosion, and dredging. As discussed in Section 3.2.1, the five major drains are gauged at their outlet to the River. Monthly major drain loading has been calculated by multiplying flow by TSS (Section 4.3.2.1). A sample loading calculation is shown in Figure 4.2, and average yearly flows and loadings for all major drains are shown in Table 4.4 below. The Table shows that the major drains are a significant source of flow and sediment to the River. Detailed calculations are in Table C-20 in Appendix C.

Table 4.4: Major Drain Flow and Loading Summary

	Average Annual (1994-1999)	
	Flows (AFY)	Loading (tons/yr)
Central Drain	72376.9	27502.4
Holtville Drain	81762.6	30710.4
Rose Drain	69307.4	26232.6
South Central Drain	27192.6	10262.2
Verde Drain	27198.3	10145.3
Total	277837.7	104852.9

4.5.2.4 *Minor Drain Loading Analysis*

Minor drains empty directly into the Alamo River and usually include less than two tributaries. While the individual flow of any of the minor drains is less than the individual flows of any of the major drains, the total flows from the minor drains is greater than the total flows from the major drains for any given month. The sediment load in the minor drains is due to the same processes as those of the major drains. As with the major drains, the flows and TSS data were estimated and measured at the outlet, thereby including all upstream inputs into the minor drains. The estimated monthly flow for the minor drains was multiplied by estimated monthly TSS concentration to determine minor drain sediment loading. The calculation is identical to major drain loading. Average 1994-1999 yearly flows and loading due to all the minor drains combined are presented in Table 4.5, below. The Table shows that the minor drains are a significant source of flow and sediment to the river. Detailed calculations are displayed in Table C-21 in Appendix C.

Table 4.5: Minor Drain Flow and Loading Summary

	Average Annual (1994-1999)	
	Flow (AFY)	Loading (tons/yr)
Ungauged Minor Drains	330557.5	198209.5
Gauged Minor Drains	32764.5	19646.3

Total Minor Drains	363322.0	217855.8

4.5.3 STORMWATER RUNOFF

Stormwater runoff, a product of precipitation events, has the capacity to cause large-scale erosion in areas prone to intense storm events and erosion. For the purposes of this TMDL, most of the stormwater runoff would originate from farmland, roads, and the Valley communities within the Alamo River watershed. However, annual average precipitation of about 3 inches explains why the Valley is known for its lack of rain. Therefore, stormwater runoff in general is not a significant source of sediment within the Alamo River watershed. The following analysis supports this contention.

The surfaces considered for potential stormwater runoff within the Alamo River watershed are essentially cropped farmland, fallow fields, roads (both paved and unpaved) and the various surface types in the urban areas. Review of Imperial County data indicates that the urbanized area draining into the Alamo River Watershed is about 10,000 acres. These surfaces represent a wide range of runoff coefficients. However, a coefficient representing asphaltic cement streets (Steele, 1979) has been chosen to represent a worst-case scenario. Because irrigation flows are much higher than one inch per hour, potential stormwater runoff from farmland can be neglected, except for areas that hypothetically were being irrigated during, just before, and just after the storm[10]. According to the UC Cooperative Extension in Holtville (UCCE), on the average, only about 20,000 acres are being irrigated on any given day (UCCE, 2000). Under a worse case scenario, it is this acreage that would have a potential to generate stormwater runoff, particularly if the soils were already saturated. Table 4.6, below, summarizes the analysis.

Table 4.6: Summary of Estimated Urban and Farmland Runoff due to Precipitation

	Urban Runoff				Farmland Runoff			
Year	Volume (ac-ft)	% of River Flow	Load (tons)	% of River Load	Volume (ac-ft)	% of River Flow	Load (tons)	% of River Load
1994	1882	0.29	384	0.16	3764	0.58	1791	0.74
1995	1513	0.25	309	0.13	3027	0.49	1441	0.63
1996	373	0.06	76	0.03	746	0.12	355	0.15
1997	2786	0.42	568	0.23	5572	0.84	2652	1.07
1998	1957	0.29	399	0.16	3915	0.59	1863	0.75
1999	824	0.13	168	0.07	1648	0.26	784	0.31

Based on the foregoing, for this phase of the TMDL, stormwater runoff is an insignificant source of sediment for the purpose of the mass balance.

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[10] Valley farmers order their water deliveries two (2) days ahead of time. Irrigation scheduling in the Valley factors in seasonal precipitation. Conceivably, however, farmers may not be able to factor in precipitation if the storm was not forecast before the order.

4.5.4 URBAN RUNOFF

Urban runoff originates from human activities. Within the context of this source analysis, these types of activities result in the conveyance of suspended solids into drains. Because the scarce population and the extremely arid climate within the Alamo River watershed, and as shown by Table 4.6, above, the contribution of urban runoff as a source of suspended sediment in the Alamo River is considered negligible.

4.5.5 IN-STREAM EROSION AND WIND DEPOSITION IN THE ALAMO RIVER

Within the Alamo River watershed in-stream erosion and wind erosion/deposition processes affect the suspended sediment load in the Alamo River. Data and/or research specific to each of the processes are extremely limited.

Shear forces at the water-streambed boundary cause in-stream erosion. Many equations are available wherein erosion is a function of velocity and streambed particle size distribution. These equations are often stream specific (i.e. valid for use under certain conditions such as flow, soil type, percent fines in the sediment load, etc.) and include constants that relate to stream conditions. Unfortunately, research regarding the quantification of these constants for various stream types is generally limited. More importantly, erosion data applicable to the drain system being analyzed herein are not available. Selection of the most accurate erosion equation is also complicated by streambed composition. If the proportion of silt-clay (<0.062mm particle diameter) is greater than 10%, there is a possibility for the existence of cohesive bed sediments. Most research on in-stream sediment transport is related to unconsolidated bed materials, which are bed materials previously deposited from upstream sources. Research involving erosion of consolidated bed materials, or cohesive bed sediments, is extremely limited. The characteristics of the Alamo River are unique with respect to flow, suspended sediment composition and load, and cross-sectional area. Research on streams with compatible features is extremely sparse, and parameters for in-stream erosion equations are currently unavailable.

Wind erosion occurs when the velocity and turbulence of wind is sufficient to dislodge soil particles. Given a sufficient velocity, transport of the particles for a relatively large distance is possible. Deposition occurs when velocity decreases sufficiently to cause particles to settle. The Imperial Valley is also known for "sand storm events" (with most of the “sand” coming from the desert areas outside the Alamo River watershed). All things being equal, reason suggests that most of wind-blown “sand” is likely to settle on land, as there is more land surface area than surface water area in the Alamo River watershed. Also, a fraction of this “sand” is probably of small enough grain size that it can remain in suspension in the water column. However, like in-stream erosion, no data have been collected on the relationship of wind deposition and TSS in the drains or the Alamo River.

Consequently, a mass balance approach was utilized to estimate the effect of in-stream erosion and wind deposition on suspended sediment concentrations. In-stream erosion and wind deposition are presumably accounted for in the Alamo River Outlet loading calculations. Namely, the load in the Alamo River at the Delta can be expressed mathematically as:

$$L_{\text{Alamo River}} = (\Sigma\ L_{\text{Drains}} + L_{\text{In-Stream River Erosion}} + L_{\text{River Wind Deposition}} + L_{\text{International Boundary}})$$

[Equation 1]

Where:

$\sum L_{Drains}$ = Sum of the load from all drains discharging into the River
$L_{In\text{-}stream\ River\ Erosion}$ = Sediment Load Contribution from in-stream erosion in the River
$L_{River\ Wind\ Deposition}$ = Sediment Load Contribution from wind deposition of sediment in the River
$L_{Stormwater\ Runoff}$ = Sediment Load Contribution from stormwater runoff into the Drain
$L_{International\ Boundary}$ = Sediment Load Contribution from Mexico

Therefore, for the purposes of the source analysis, the loads of in-stream erosion and wind deposition processes in the Alamo River itself can be combined into a single load (hereafter defined as "$L_{w\text{-}erosion}$"). This load can be quantified by subtracting the sum of the loading from the major drains, plus the load from the minor drains, plus the load from Mexico from the total sediment load in the Alamo River, or:

$$L_{w\text{-}erosion} = L_{Alamo\ River} - (\sum L_{Drains} + L_{International\ Boundary})$$

[Equation 2]

A sample calculation to estimate $L_{w\text{-}erosion}$ is shown in Figure 4.6, below. Detailed calculations are shown in Table C-22 in Appendix C.

$$L_{w\text{-erosion, average}} = L_{\text{Alamo River, average}} - \left(\sum L_{\text{Drains, average}} + L_{\text{International Boundary, average}}\right)$$

$$L_{w\text{-erosion, average}} = 329{,}477.4 \text{ tons} - (322{,}708.6 + 145.7)\text{tons} \approx 6{,}623 \text{ tons/year}$$

Figure 4.6: Sample Estimation of the Average Annual In-Stream Erosion and Wind Deposition in the Alamo River

The average sediment load contributed by the combination of in-stream erosion and wind deposition, for the period of this analysis (1994-99), is 6,623 tons/year, or approximately 2% of the current sediment load present in the Alamo River at its outlet. This contribution corresponds with an average increase in Alamo River TSS concentrations of approximately eight (8) mg/L.

4.5.5.1 DRAIN SEDIMENT SOURCES

While this TMDL focuses on the Alamo River, it is important to understand the loading of the drains to implement appropriate controls wherever possible valley-wide. Thus, this section provides a rough estimate on the relative contribution of sediment by the various sources discharging into the drains, including naturally occurring inputs (e.g., wind deposition). Sources contributing to TSS loading in the agricultural drains include tailwater, dredging processes, in-stream erosion, wind deposition, stormwater and urban runoff, and NPDES facilities. Mathematically, the sediment load in any drain can be expressed as:

$$L_{Drain} = (L_{Tailwater} + L_{Dredging}) + L_{In\text{-}Stream\ Drain\ Erosion} + L_{Drain\ Wind\ Deposition} + L_{Stormwater\ Runoff} + L_{Urban\ Runoff} + L_{NPDES}$$

[Equation 3]

Where:

$L_{Tailwater}$ = Sediment Load Contribution from tailwater from farmland
$L_{Dredging}$ = Sediment Load Contribution from drain dredging
$L_{In\text{-}stream\ Drain\ Erosion}$ = Sediment Load Contribution from in-stream drain erosion
$L_{Drain\ Wind\ Deposition}$ = Sediment Load Contribution from wind deposition in the drain
$L_{Stormwater\ Runoff}$ = Sediment Load Contribution from stormwater runoff into the drain
$L_{Urban\ Runoff}$ = Sediment Load Contribution from urban runoff into the drain
L_{NPDES} = Sediment Load Contribution from NPDES facilities discharging into the drain

Sediment loading from stormwater and urban runoff, can be neglected as discussed in Sections 4.3.4 and 4.3.5, respectively.

The sediment loading from dredging operations is difficult to quantify. However, Regional Board staff data indicate that it is significant. IID implements a dredging program for the purpose of removing deposited sediment within the drainage network. According to IID, "The primary 'problem areas' are drains that are located in sandy soils or light silty soils with slopes of less than 0.001, and that have adjacent water table of six feet or less. A drain may also be classified as a problem area for cleaning purposes due to prolific growth of aquatic vegetation or growth of grasses and annuals along the water's edge, which impedes the flow of water." IID performs an average of four (4) simultaneous dredging operations in the Alamo River watershed each day. Actual dredging is considered to occur for fifty (50) minutes of every hour worked[11]. Dredging is accomplished using an excavator, which is extended perpendicular to stream flow. During the process, the bucket is scraped against the bed and up the bank on each pass, removing sediment from the bed and vegetation that prevents bank sloughing and acts as a filter strip. The length of drain dredged and dredging time for a particular drain are dependent upon the volume of sediment to be removed from the particular drain.

The following calculation is intended to illustrate the potential impact of dredging. Dredging can effectively increase downstream TSS concentration from the low hundreds to as high as five thousand (5,000) mg/L. The effect of dredging on suspended sediment at the outfall of any particular drain is calculated by determining the percent of flow in the drain affected by dredging. The affected flow is then multiplied by the concentration to determine loading. Dredging calculations are exhibited in Figure 4.7. Potential annual loading from dredging operations are shown in Table 4.7, below. Detailed dredging data and calculations are displayed in Table C-23 in Appendix C.

[11] Personal communication with Mr. Steve Knell of IID on March 15, 2000

Percent Time Dredged

- $1\,\text{crew}: 50\frac{\text{min}}{\text{hr}}\times 9\frac{\text{hr}}{\text{day}}\times 4.5\frac{\text{day}}{\text{week}}\times 52\frac{\text{week}}{\text{yr}}\times\frac{\text{hr}}{60\,\text{min}}\times\frac{\text{day}}{24\,\text{hr}} = 73.125\frac{\text{day}}{\text{yr}}$

$$73.125\frac{\text{day}}{\text{yr}}\times\frac{\text{yr}}{365\,\text{days}} = 0.20 \qquad \Rightarrow 1\text{ crew dredges }20\%\text{ of the time on a yearly basis.}$$

$$\text{Therefore, for 4 crews}: 4\times 0.20 = 0.80 \qquad \Rightarrow \text{With 4 dredging crews, dredging occurs }80\%\text{ of the time on a yearly basis.}$$

Since there are 76 drains in the Alamo Watershed :

$$\frac{0.80}{76\,\text{drains}} = 0.011 \qquad \Rightarrow \text{Dredging occurs }1.1\%\text{ of the time in any drain.}$$

- Dredging Impact = Flow × 0.011 × Dredging Concentration

January 1999 Major Drains Dredging Impact =

$$19{,}973.6\,\text{acre}\cdot\text{ft}\times 0.011\times 5000\frac{\text{mg}}{\text{L}}\times 0.0013597\frac{\text{tons}\times\text{L}}{\text{acre}\cdot\text{ft}\times\text{mg}} = 1{,}429\,\text{tons}$$

Figure 4.7: Sample Calculations – Dredging Effects

Table 4.7: Dredging Summary

	Flow Affected (acre-ft)	Load (tons)
Major Drains	2925	19883
Minor Drains	4159	26000
Total	7084	45883

To reiterate, the above calculations represent potential dredging impacts. Due to the lack of data, dredging has been combined with agricultural minor and major drain sources for the purpose of this source analysis.

Erosion within the Ag Drains is a much more variable process than the erosion of agricultural fields in the Imperial Valley. In some locations it is probably not a significant source of sediments, while other locations appear to have significant erosion due to undercutting and mass wasting of the drain banks. As mentioned above, downward erosion of the drains is effectively controlled by the over 250 drop structures present in the drains tributary to the Alamo River. Nearly all of the drains have either relatively stable channels, with no net downward erosion, or are in a state of aggradation, in which there is more sediment being deposited as a result of discharges from agricultural fields than is being eroded and transported out of the channel, thus requiring dredging in order to maintain adequate drainage. Over the long term, the various drains within the watershed have the net effect of being either minor sediment sources, where the net contribution of erosion and wind deposition are expected to cause about the same relative magnitude of increase in sediment concentrations as the erosion within the River, or net sediment sinks, where large amounts of the sediments which are discharged to them are removed via dredging. Due to a lack of extensive data on tailwater sediment concentrations, or long term erosion contributions within the drains, the contribution of drain erosion has been combined with the contribution of irrigated agricultural fields and dredging into the general categories of agricultural drainage from major and minor drains for the purpose of this source analysis.

4.6 ANALYSIS RESULTS

An annual sediment source summary for the Alamo River is presented numerically in Table 4.8 and graphically in Figure 4.8. The results indicate that practically all of the suspended sediment loading in the Alamo River is due to drain loading.

Table 4.8: 1994-1999 Alamo River Sediment Source Summary

	Sediment Loading (tons/year)	Percent of total Sediment Load	Flow (acre-ft/year)	Percent of Total Flow
Minor Drain Agricultural Discharges	217,799	66.1%	363,322	56%
Major Drain Agricultural Discharges	104,694	31.8%	277,838	42%
Point Sources (NPDES)	215	0.1%	11,550	2%
International Boundary	146	<0.1%	1,436	<1%
Natural Sources	6,623	2.0%		<1%
Total	329,477	100.00%	654,146	100.00%
Flow at Outlet (acre-ft/yr)	642,595			
Outlet Concentration (mg/L)	377			

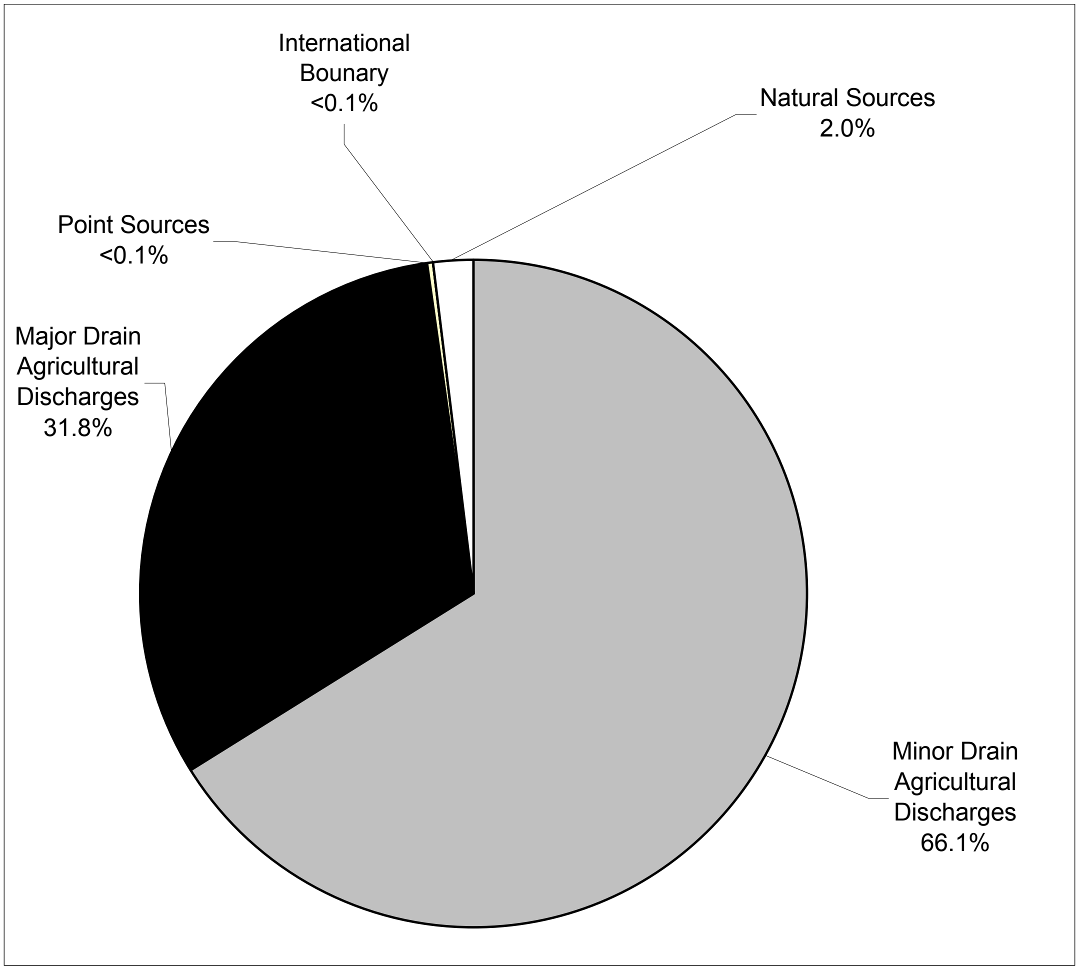

Figure 4.8: Sources of Sediment to the Alamo River

4.6.1.1 Proposed Activities To Refine Analysis

Several activities are planned in order to refine the source analysis and verify assumptions and statistical inferences. In an effort to better characterize minor drain loading, Regional Board staff proposes that both flow and TSS be monitored in a statistically significant number of minor drains. A more refined understanding of major drain loading is advocated through continued flow monitoring by IID and a monthly TSS monitoring program. In addition, a detailed study on erosion within the Alamo River channel and the Ag Drains could be utilized to more accurately quantify the amount of sediment being contributed by erosion in these areas, and identify methods to reduce erosion in the Ag Drains where necessary. Wind erosion and deposition processes within the Alamo River watershed are another area in which further research can more accurately quantify the magnitude of sediment loading from this source. The proposed monitoring activities are described in Section 7 of this TMDL Report.

5. LINKAGE ANALYSIS

5.1 INTRODUCTION

The Linkage Analysis describes the relationship between the numeric targets and the sources of sediment, and the analytical basis upon which the load allocations for these sources are based, such that the total loading to the Alamo River will result in attainment of the numeric target.

5.2 ANALYTICAL BASIS

Both the flow and sedimentation regimes within the Alamo River watershed are relatively stable, and the sediment and water sources within the watershed are relatively uniform and widespread. These factors allow relatively simple linkages between sources of sediment, numeric targets, and the total assimilative capacity of the Alamo River for sediment. As described above, the water within the Alamo River consists almost entirely of the agricultural discharges from the Ag Drains, and the majority of the suspended sediments in the Alamo River also are discharged to the River via the drains. Therefore, no significant dilution of the concentrations of sediments in the drains occurs in the Alamo River. Due to the sizes of particles commonly found within the Alamo River watershed (mostly colloidal clays and silt, with some fine sands) and the relatively short time of travel of the River [approximately two days (Huston et al. 2000)], settling is not expected to occur at significant levels within the River. Therefore, a majority of the sediments that enter the Alamo via its tributaries are expected to travel the entire length of the River to its delta. For these reasons, the sediment concentration in the Alamo River is basically the sum of the sediment loads contributed by the Ag Drains and the sediment loads contributed by natural sources, divided by the sum of the flows from the drains:

$$\text{Alamo Sediment Concentration} = \frac{\Sigma\ \text{Drain Sediment Loads} + \Sigma\ \text{Direct Natural Sources}}{\Sigma\ \text{Drain Flows}}$$

[Equation 4}

The assimilative capacity of the Alamo River for sediment is defined as the highest sediment loading that the Alamo can assimilate without exceeding its numeric targets. Therefore, the assimilative capacity per unit volume of the River for any time period is defined as the sum of the contribution of the allowable loads during that time period plus the contribution of the natural sources during that time period and a margin of safety, or symbolically:

$$\frac{\text{Assimilative Capacity}}{\text{Unit Volume}} = \text{Numeric Target} = \frac{\sum \text{Allowable Loads}}{\sum \text{Drain Flows}} + \frac{\sum \text{Direct Natural Sources}}{\sum \text{Drain Flows}} + \text{Margin of Safety}$$

[Equation 5]

The contribution of the allowable loads is therefore the numeric target, minus the contribution of the natural sources and a margin of safety, or symbolically:

$$\frac{\sum \text{Allowable Loads}}{\sum \text{River Inflows}} = \text{Numeric Target} - \frac{\sum \text{Direct Natural Sources}}{\sum \text{Drain Flows}} - \text{Margin of Safety}$$

[Equation 6]

The Numeric Target is defined above as 200 mg/L, and the margin of safety is defined in Section 6.2, below, as 10 mg/L. The Source Analysis shows that the direct natural sources of sediment to the Alamo, erosion within the River channel, wind-deposited sediment in the River, and stormwater runoff, are believed to be a relatively minor source, comprising less than 3%, or approximately 10 mg/L, of the Alamo's current sediment load. The maximum contribution of the allowable loads is therefore:

$$\frac{\sum \text{AllowableLoads}}{\sum \text{River Inflows}} = 200\ \text{mg/L} - 10\ \text{mg/L} - 10\ \text{mg/L} = 180\ \text{mg/L}$$

To convert this concentration into a sediment load for a particular time period, this concentration is then multiplied by the total flow volume for the appropriate time period. For an average year, the flow of the Alamo at its outlet is approximately 642,595 acre-feet per year (AFY), and the sum of the allowable loads is then:

$$\sum \text{Allowable Loads} = 180\ \text{mg/L} \times 642{,}595\ \text{acre-feet/yr} \times \text{converstion factor} \approx 157{,}000\ \text{tons/yr}$$

The total contribution of the allowable loads is the sum of the entire load allocations defined below. These load allocations will therefore, when achieved, result in suspended sediment concentrations that are within the assimilative capacity of the Alamo River, thus achieving the numeric targets described above.

6. ALLOCATIONS

6.1 INTRODUCTION

The USEPA TMDL Guidelines (USEPA 1991) define the maximum allowable pollutant load as the total load of a particular pollutant in a water body that ensures the designated beneficial uses are attained and maintained. The guidelines recommend that the TMDL be reduced by a factor that accounts for uncertainty, the margin of safety, and, when necessary, an allocation for future growth. The remaining allowable pollutant load is distributed equitably among existing point sources and nonpoint sources of pollution. In mathematical terms, this is expressed as:

$$\left.\begin{aligned}\text{TMDL} = {} & \sum \text{Load Allocations for nonpoint sources} \\ & +\sum \text{Waste Load Allocations for point sources} \\ & +\text{MOS}\end{aligned}\right\} \leftarrow \textbf{[Equation 7]}$$

6.2 MARGIN OF SAFETY

Most of the uncertainty in the source analysis relates to the flow estimates and the limited sediment data that was used to calculate the current load contributions from the Ag Drains. An explicit margin of safety is needed to account for the uncertainty inherent in calculating the relative pollutant loading based on the limited available data. Natural sources of sediments to the Alamo River, in-stream erosion and wind deposition, have been quantified in the source analysis by subtracting the total load contributions, which were estimated based on available flow and TSS data, from the measured sediment load within the Alamo River. Due to the inherent error in flow measurement upon which the estimation of the contributions from natural sources were based, as discussed in Section 4.2.2.1, and the other uncertainties stated above, the margin of safety is explicitly established as 10 mg/L of the yearly ambient sediment concentration of the Alamo River. This margin of safety is roughly equal to the estimated load from natural sources. Therefore, if the actual load from natural sources is up to double the estimated load from natural sources, the margin of safety will be adequate to ensure that numeric targets are met by the current load allocations.

6.3 ALLOCATIONS METHODOLOGY

TMDL allocations herein deal exclusively with the sediment inputs into the Alamo River—namely, agricultural drain discharges, the discharge at the International Boundary, and natural sources (in-stream river erosion, and wind-deposited sediment into the River). In order to support the monitoring and assessment portion of the TMDL, and to account for some of the uncertainty regarding the load contribution from the various drains, the Alamo River was divided into six (6) sections as follows:

Section 1: This segment covers the River from the IID gauging station immediately north of the intersection of the All American Canal and the Alamo River channel (i.e., immediately downstream of the International Boundary) to a point approximately 100 feet downstream of the Ninth Street Drain outfall into the River, a point identified hereafter as “AR-1”.

Section 2: This segments encompasses the River from AR-1 to a point downstream of the Pomello Drain outfall into the River and upstream of the Graeser Drain outfall into the River, a point hereafter referred to as “AR-2”.

Section 3: This segment covers the River from AR-2 to a point downstream of the Holtville Main Drain outfall into the River and upstream of the Olive Drain outfall into the River, a point hereafter referred to as “AR-3”;

Section 4: This river segment extends from AR-3 to a point downstream of the Wills Drain outfall into the River and upstream of the Moss Drain outfall into the River, a point hereafter referred to as “AR-4”;

Section 5: This segment covers the River from AR-4 to a point downstream of the Rockwood Drain outfall into the River and upstream of the C drain outfall into the River, a point hereafter referred to as “AR-5”;

Section 6: This segment covers the River from AR-5 to the point where it intersects the Garst Road, a point hereafter referred to as “AR-Outlet”.

To fairly allocate mass load amongst the drains, the total mass load allocated for the segment has been distributed based on the proportion of flow of each drain to the total flow within the segment on a yearly basis. This type of allocation takes into account the agricultural acreage served by each drain and promotes watershed-wide implementation of BMPs. Yearly mass load allocations are necessary during this phase of the TMDL to account for monthly fluctuations and data uncertainty. As more data become available, it may be necessary to establish monthly load allocations to ensure year-round compliance with the loads.

6.4 LOAD ALLOCATIONS

Load allocations are required for all nonpoint sources [40 CFR 130.2(g)]. The source analysis section of this TMDL divides the Alamo River watershed into seventy-one (71) minor drains and five (5) major drains. Based on the source analysis, ten (10) mg/L within the Alamo River are allocated to natural sources. The balance of the TSS is due to loading from both minor drains and major drains. Load allocation computations are based on the source analysis presented in Section 4. The concentration used to determine the total load allocation for each section is computed by adding the allocation for erosion and wind deposition to the margin of safety (Section 4.3.2) in terms of concentration, and subtracting this sum from the suspended sediment target concentration for the Alamo River. Total load allocations (for all drains within a section) for each section can then be determined by multiplying the total load allocation concentration by the total flow within the section. Load allocations for each drain are determined by multiplying the percent flow by the total section load allocation. A sample calculation is shown in Figure 6.1, below. Sediment load and waste load allocations, in tons per year for each drain, are presented in Table 6.1, located on the following pages. Detailed calculations are presented in Appendix D. The load allocation for the Alamo River at the International Boundary is set at the current loading, as calculated in the Source Analysis, above.

- $\text{Percent Flow} = \dfrac{\text{Drain Flow}}{\text{Total Section Flow}}$

$$\text{Warren Drain \% Flow} = \frac{10{,}575.4 \text{ acre - ft}}{71{,}453.6 \text{ acre - ft}} = 14.80\%$$

- $\text{Load Allocation Concentration} = \text{Target Concentration (mg/L) - (instream erosion + wind deposition) - Margin of Safety}$

$$\text{Load Allocation Concentration} = 200 \text{ mg/L} - 10 \text{ mg/L} - 10 \text{ mg/L} = 180 \text{ mg/L}$$

- $\text{Section Annual Load Allocation} = \text{Load Allocation Concentration} \times \text{Section Flow} \times \text{Conversion Factor}$

$$\text{Section 1 Load Allocation} = 180 \frac{\text{mg}}{\text{L}} \times 71{,}453.6 \text{ acre} \cdot \text{ft/year} \times 0.001359686 \frac{\text{tons} \cdot \text{L}}{\text{acre} \cdot \text{ft} \cdot \text{mg}} = 17{,}487.8 \text{ tons/year}$$

Figure 6.1: Load Allocation Sample Calculation

Table 6.1: Sediment Load and Waste Load Allocations

River Section		# Of Drains Included in Segment	Sediment Load and Waste Load Allocation (tons/year)[1,2]
Alamo River immediately downstream of the International Boundary, at the IID gauging station, a point identified hereafter as "AR-0".		None	146
Section 1:	Downstream from AR-0 to a point approximately 100 feet downstream of the Ninth Street Drain outfall into the River, a point identified hereafter as "AR-1".	8	17,488
Section 2:	This segments encompasses the River from AR-1 to a point downstream of Pomello Drain outfall into the River and upstream of Graeser Drain outfall into the River, a point hereafter referred to as "AR-2".	7	25,255
Section 3:	This segment covers the River from AR-2 to a point downstream of the Holtville Main Drain outfall into the River and upstream of the Olive Drain outfall into the River, a point hereafter referred to as "AR-3".	8	24,501
Section 4:	This river segment extends from AR-3 to a point downstream of the Wills outfall into the River and upstream of the Moss outfall into the River, a point hereafter referred to as "AR-4".	12	31,887
Section 5:	This segment covers the River from AR-4 to a point downstream of the Rockwood Drain outfall into the River and upstream of the C Drain outfall into the River, a point hereafter referred to as "AR-5".	22	30,002
Section 6:	This segment covers the River from AR-5 to the point where it intersects the Garst Road, a point hereafter referred to as "AR-Outlet".	12	19,469
Tailwater outfalls discharging directly to the Alamo River		[a]	7,830
TOTAL LOAD ALLOCATIONS		72	156,577
WASTE LOAD ALLOCATIONS			3,196
Natural Sources (Instream erosion, wind deposition, etc)		None	8,737
Margin of Safety		None	8,737[3]
TOTAL ASSIMILATIVE CAPACITY		76	177,247[4]

[1]= The sediment load allocation for any particular reach shall be distributed proportionately amongst the agricultural drains within that particular reach based on the relative flow

contribution of each drain to the total flow contribution to the reach from the drains within the reach. The Executive Officer shall be responsible for determining proportional sediment load allocations amongst the agricultural drains.

[2]= The sediment load allocations herein have been calculated based on the estimated individual average drain flows within the reach for the 1994-1999 period. At lower or higher drain flows, the average annual load allocation for a particular reach shall not exceed the load given by:

$LA_R = (180)*(Q_R)*(0.0013597)$, where:

LA_R = Load Allocation for any of the Alamo River reaches identified above (tons/yr).

Q_R = Reach Flow (ac-ft) = Total flow contribution to the reach from the drains within the reach (ac-ft).

[3]= It corresponds to 10 mg/L. The margin of safety is roughly equal to the estimated load from natural sources to the Alamo River. This margin of safety allows for the loading of sediment from natural sources to the river to be double the natural source loading estimated in the Source Analysis without exceeding the Numeric Target.

[4]= Previously reported as 174,747 due to typographical error

[a]= The number of outfalls has not been determined.

6.4.1 WASTELOAD ALLOCATIONS

TMDL regulations require waste load allocations for all point sources [(40 CFR 130.2(h)]. There are no direct discharges of wastes from point sources of pollution directly into the Alamo River. However, thirteen (13) NPDES facilities are permitted to discharge into drains tributary to the River. Table 4.8 shows that the loading from these facilities is relatively minor in comparison to the loading from nonpoint sources. All point sources of pollution in the Alamo River watershed have current NPDES permits, which prescribe effluent limitations for TSS concentrations. The wasteload allocations for these facilities are set at double their current suspended solids loading rates in order to allow for potential expansion of these facilities. An additional wasteload allocation of 1000 tons per year is set for future point sources. Table 6.2, below, summarizes the TSS limits for these facilities, and the wasteload allocations set for them in this TMDL. The total of all of these wasteload allocations is still less than 2% of the total assimiliative capacity of the Alamo River, and therefore these discharges will not significantly effect the TSS concentrations in the River.

Table 6.2 [1]: Waste Load Allocations for Point Sources in the Alamo River Watershed

Facility	NPDES #	Discharge Location	NPDES Permit Limits as of 6-2001[2] (tons of suspended solids per year)	Waste Load Allocation[3] (tons of suspended solids per year)
City of Calipatria WWTP	CA 0105015	G Drain	246.0	491.9
City of El Centro WWTP	CA 104426	Central Drain	365.5	731.1

City of Holtville WWTP	CA 0104361	Pear (Palmetto) Drain	38.8	77.7
City of Imperial MWTP	CA 0104400	Rose Drain	64.0	127.9
Heber Public Utilities District WWTP	CA 0104370	Central Drain	20.6	41.1
Imperial Community College District WWTP	CA 104299	Central Drain	4.6	9.1
Sunset Mutual Water Co	CA 104345	Central Drain	2.3	4.6
Country Life MHP	CA 0104264	Central Drain	5.7	11.4
Covanta Heber Geothermal	CA 0104965	Central Drain	195.6	391.1
El Centro Steam Plant	CA 104248	Central Drain	NA	95.0
New Charleston Power Plant	CA 101990	Rose Drain	6.9	13.7
IID Grass Carp Hatchery	CA 7000004	Central Drain	NA	182.8
Rockwood Gas Turbine Station	CA 0104949	Bryant Drain	1.3	2.6
Imperial Valley Resources Biomass Waste Fuel Power Plant	CA 0105066	Rose Drain	NA	15.5
Future Point Sources	NA	NA	NA	1000.0
TOTAL			1098951	3196

Footnotes for Table No. 6-2:

[1] Does not include volatile suspended solids determination.

[2] Calculated using design flows and 30-day mean TSS limits.

[3] Determined using double the current effluent limits to allow for facility expansion. For the three energy generating facilities without current TSS limits, a 30 mg/L TSS limit is used for current effluent limit in this calculation.

6.4.2 EVALUATION OF POTENTIAL CHANGES IN SUSPENDED SEDIMENT LOADING

The two most likely events to affect suspended sediment concentrations within the Alamo River watershed are population expansion and water transfer proposals between IID and various parties, including the San Diego County Water Authority, Coachella Valley Water District, and Los Angeles Metropolitan Water District. The following paragraphs discuss these potential impacts.

6.4.2.1 Population Growth

The source analysis indicates that sediment loading of the Alamo River watershed can be almost exclusively attributed to nonpoint sources of pollution. Future population growth within the watershed is not expected to increase the sediment load in the River. An increase in population Valley-wide would result in an increase in the amount of wastewater discharged from the WWTPs. WWTP effluent limits for TSS are less than 100 mg/L (see Table 6.2). The effect of an expanded population would be to decrease the TSS concentration within the drains and the Alamo River. Consider, for example, the extreme case of a 400% population increase within the next 20 years[12] such that the discharges from NPDES facilities increase to 31,225 ac-ft/yr. Assuming all WWTP effluent has a TSS concentration of 90 mg/L, the corresponding TSS loading to the River would be no more than 3,820 tons/yr, or just over 2% of the assimilative capacity of the Alamo River. A sample calculation is shown in Figure 6.2.

$$\text{Alamo River Loading} = 31{,}225\,\frac{\text{acre-ft}}{\text{yr}} * 90\,\frac{\text{mg}}{\text{L}} * 0.001359\,\frac{\text{tons} * \text{L}}{\text{acre-ft} * \text{mg}} = 3{,}819\,\frac{\text{tons}}{\text{yr}}$$

Figure 6.2: Population Effects – Sample (90 mg/L)

As this calculation indicates, loading from these facilities is negligible, even given a significant increase in the population of the watershed.

6.4.2.2 Water Transfers

It is expected that IID irrigation deliveries may decrease as much as 300,000 ac-ft/yr because of potential water transfer between IID and other water agencies (e.g., San Diego County Water Authority). The water to be transferred would be irrigation water “conserved” by IID and Imperial Valley farmers. Using the ratio of the Alamo River flows to the total outflow of the IID drainage system (Table 4.1 - Section 4.2.1 Source Analysis), and assuming that the 300,000 ac-ft/yr reduction in irrigation deliveries will result in an equal decrease in total drain flow as a worst case scenario, the corresponding flow in the Alamo River is 448286 ac-ft/yr (642,595 – (300,000 x (642,595/992,122)) = 448,286 ac-ft/yr). Using the TMDL target of 200 mg/L, minus the estimated 10 mg/L contributed by natural sources, minus the 10 mg/L for the Margin of Safety, the load at the outlet of the Alamo River would be 109,660 tons/yr (Figure 6.3, below). In other words, the projected result of a decrease in irrigation deliveries is a lower mass loading.

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[12] Data published by Valley of Imperial Development Alliance (VIDA) actually shows that the population for the entire Imperial Valley would only increase by 100,000 within the next 20 years (VIDA, 1999).

$$\text{Alamo River Loading} = 448{,}286 * 180\,\frac{\text{mg}}{\text{L}} * 0.001359\,\frac{\text{tons} * \text{L}}{\text{acre-ft} * \text{mg}} = 109660\,\frac{\text{tons}}{\text{yr}}$$

Figure 6.3: IID Transfer Effects on Alamo River Loading

Measures being evaluated by IID to conserve the water include tailwater pump-back facilities and more efficient irrigation methods, which would also result in a decrease in the TSS loading and concentrations.

7. IMPLEMENTATION PLAN

7.1 LEGAL AUTHORITY AND REQUIREMENTS

7.1.1 INTRODUCTION

The Porter-Cologne Water Quality Control Act, which is contained in Division 7 of the California Water Code (CWC), establishes the responsibilities and authorities of the Regional Water Quality Control Board, including authority and responsibility for regional water quality control and planning. The Regional Board establishes water quality objectives by amending its Water Quality Control Plan for the Colorado River Basin (Basin Plan). It controls pollution from point sources by implementing a variety of full regulatory programs, including the NPDES Program for point sources discharging into waters of the United States. The State's approach to control nonpoint source pollution is contained in the State's "*Plan For California's Nonpoint Source Pollution Control Program*," including "*Volume I: Nonpoint Source Program Strategy and Implementation Plan for 1998-2013 (PROSIP)*" and "*Volume II: California Management Measures for Polluted Runoff (CAMMPR)*" (hereafter referred to as "State NPS Management Plan").

The cornerstone of the State NPS Management Plan is control of nonpoint source pollution by implementing a "three-tiered approach," consisting of implementation of self-determined best management practices (Tier 1), regulatory-encouraged best management practices (Tier 2), and effluent requirements (Tier 3). Sequential movement through the tiers (e.g. Tier 1 to Tier 2 to Tier 3) is not required of the Regional Board. Depending on the water quality impacts and severity of the NPS problem, the Regional Board may move directly to the enforcement actions specified in Tier 3. Also, the Regional Board can choose to implement a combination of water quality control mechanisms from each of the Tiers as well as additional remedies (e.g., enforcement orders) as provided under the CWC.

7.1.2 REQUIRED COMPONENTS OF TMDL IMPLEMENTATION PLANS

In adopting water quality objectives for water quality control (e.g., TMDLs), the Regional Board must adopt an implementation plan for achieving the water quality objectives[13] (CWC § 13242). The implementation plan must include, but needs not be limited to: (1) a description of the nature of actions which are necessary to achieve the water quality objectives, including any recommendations for appropriate action by any entity, public or private; (2) time schedules for actions to be taken; and (3) a description of surveillance to be undertaken to determine compliance with the objectives. The Basin Plan amendment process has been certified by the Secretary for Resources as "functionally equivalent to," and therefore exempt from, the California Environmental Quality Act (CEQA) requirement for preparation of an environmental

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[13] Also, 40 CFR 130.6(c)(6) requires identification of implementation measures necessary to carry out a Water Quality Control Plan, including financing, the time needed to implement the Plan, and the economic, social and environmental impact of carrying out the plan in accordance with Clean Water Act Section 208(b)(2)(E).

impact report or negative declaration and initial study (California Code of Regulations (CCR) Title 14, §15251(g)). However, a CEQA-required Environmental Checklist must be completed.

7.1.3 OVERVIEW OF PROPOSED TMDL IMPLEMENTATION PLAN

Consistent with the aforementioned requirements and the State's NPS Management Plan, staff is proposing that the Regional Board consider adopting a Basin Plan amendment that establishes the TMDL and includes an implementation plan to achieve compliance with the TMDL. The implementation plan contained in the proposed Basin Plan amendment and discussed herein specifies: (1) implementation actions required of responsible parties and recommended implementation actions for other agencies/organizations; (2) time schedules for actions to be taken; and (3) a description of the monitoring and surveillance to be undertaken to determine progress toward attaining deadlines and milestones. Also, the potential environmental impacts of the proposed Basin Plan amendment are assessed in the CEQA Checklist and the Determination with respect to Significant Environmental Impacts (Attachment 3) prepared as part of this TMDL. Further, pursuant to CWC § 13141 and § 13241, the proposed implementation plan identifies available means for complying with this TMDL (Section 7.4 of this document); evaluates the economic impacts of implementation of the TMDL (Attachment 4); and identifies potential sources of funding for implementation of BMPs for NPS pollution control (Section 10 of this document).

The proposed implementation plan essentially requires that: (1) farmers discharging sediment into the Alamo River and/or into its tributary drains to submit and implement water quality improvement plans, which identify self-determined sediment control measures and to document implementation and water quality improvements; (2) the Imperial Irrigation District submit and implement a revised Drain Water Quality Improvement Plan to address the water quality impacts caused by its operation and maintenance of the drainage system; and (3) the U.S. Government submit and implement measures to prevent discharges of waste from Mexico from violating this TMDL. The plan also recommends that the Imperial County Farm Bureau implement its "Voluntary Watershed Program" throughout the Imperial Valley to address sediment pollution from farmland.

In instances where there are insufficient data, USEPA Guidance (USEPA 1991) allows for use of a "phased" approach to TMDL development and implementation. When implementing a phased approach, the numeric target, load allocations, waste load allocations, and margin of safety must be set. The phased approach, however, provides for modifying these numeric values based on new data. Meanwhile, efforts by dischargers can be implemented to reduce pollutant loadings. This TMDL requires additional data to determine if the load reductions are adequate and to more accurately determine assimilative capacities and pollution allocations, among others. Hence, the proposed Basin Plan amendment implements the TMDL in four phases covering a period of 13 years.

7.2 DISCHARGERS AND RESPONSIBLE PARTIES

All dischargers of waste are responsible for the quality of their waste and are responsible for ensuring that discharges do not adversely impact the beneficial uses of waters of the State[14].

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[14] As described above in the Source Analysis, the contribution of sediment from the NPDES facilities discharging into the Alamo River watershed is insignificant. Also, their contribution of suspended solids (as measured by TSS) to

For the purposes of this TMDL, dischargers include owners and operators of NPDES facilities; the Imperial Irrigation District; and farm landowners, renters/lessors, and operators/growers discharging or potentially discharging wastes into the waters of the State. The U.S. Section of the International Boundary and Water Commission and the United States Environmental Protection Agency are also responsible parties for the purpose of ensuring that discharges from Mexico do not violate the TMDL.

7.2.1.1 Imperial Irrigation District

The IID is the largest stakeholder within the Salton Sea Transboundary Watershed. It operates and maintains the irrigation canals and Ag Drains. As the drainage management agency, the IID maintains over 1,400 miles of constructed agricultural ditches (drains). The IID is discharging wastes into the drains and the Alamo River and is therefore a responsible party for the purposes of implementing actions to comply with this TMDL.

7.2.1.2 Farm Landowners, Renters/Lessors, and Operators

Landowners have discretionary control of their land. Therefore, they have ultimate responsibility to control practices taking place on their lands that threaten the quality of or are creating a condition of pollution in the waters of the State. Similarly, to the degree that they are aware that the practices of their renters/lessors threaten water quality or are creating a condition of pollution in the waters of the State, the landowners can be held ultimately responsible for cleanup purposes. As the renters/lessors have day-to-day control of their farming operations, they too have responsibility for pollution control. For the purposes of this sediment TMDL, operators are defined as Imperial Irrigation District agricultural water account holders. These are individuals or corporations who purchase water from the Imperial Irrigation District to irrigate farmland and, as a result, are likely to discharge waste into waters of the State. Operators may also be the above-mentioned landowners as well. As the operators have day-to-day control over the farming operations and the discharge of waste, they too are considered dischargers. There are approximately 6290 farm water users (i.e., operators) in the Imperial Irrigation District (IID 1998a).

7.2.1.3 The United States International Boundary and Water Commission (IBWC) and United States Environmental Protection Agency

The IBWC is a US-Mexican Federal agency with roots in the "Treaty of Guadalupe Hidalgo of Peace, Limits and Settlement," which was signed by both Countries in February 1848. IBWC was established as the "International Boundary Commission" (IBC) in 1889 to deal with boundary issues. In 1944, the US and Mexico signed the Treaty entitled "Utilization of Waters of the Colorado and Tijuana Rivers and of the Rio Grande" (a.k.a. the "Mexican-American Water Treaty"), which was ratified by the US Congress in 1945. The Mexican-American Water Treaty changed the name of IBC to IBWC and expanded the jurisdiction and responsibilities of the IBWC[15]. The US Section of the IBWC is part of the State Department. Its responsibilities include the application of boundary and water treaties between the two countries and settling differences that may arise in their application. The treaty specifically charged the IBWC with the

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the Alamo River is negligible. Therefore, no additional effluent limitations for these facilities are necessary to meet the objectives of this TMDL

[15] Both the United States and Mexico have commissioners appointed to IBWC. Within Mexico, IBWC is called "Comision Internacional de Limites y Aguas" (CILA).

solution of border sanitation problems and other border water quality problems. In August 1983, the Presidents of Mexico and the United States signed the La Paz Agreement for protection and improvement of the environment in the border area. The La Paz Agreement makes the USEPA the US coordinator for pursuing practical, legal, institutional, and technical measures for protecting the quality of the environment in the border area. Currently, the Comision Nacional del Agua (CNA) has primary responsibility for border water problems for Mexico. Based on the foregoing, the State Department's IBWC and the USEPA have primary responsibility for ensuring that discharges of wastes from Mexico do not violate or contribute to a violation of this TMDL downstream of the International Boundary.

7.3 THIRD PARTY COOPERATING/COORDINATING AGENCIES AND ORGANIZATIONS

This subsection describes the key cooperating agencies and organizations, and the role that they can play in TMDL implementation. Cooperating third party agencies and organizations can play a pivotal role in achieving implementation and attaining TMDLs. These entities may have technical expertise, resources, and organizational structures that will facilitate effective implementation of practices to address sediment pollution.

7.3.1 UNIVERSITY OF CALIFORNIA COOPERATIVE EXTENSION, HOLTVILLE FIELD STATION

The University of California Cooperative Extension (UCCE) was developed to apply the resources of the university to local communities. It offers workshops, programs, and technical assistance to growers on a broad range of agricultural topics, including conservation management practices. UCCE farm advisors conduct research on existing local problems, and extend that information, along with other related research, to local growers. The UCCE's Holtville Field Station is implementing demonstration projects and conducting research for erosion control, has the organizational structure to provide training courses and workshops, and could serve as a technical assistance agency for interested growers and irrigators. Staff from the UCCE has been instrumental in the development of this TMDL.

7.3.2 IMPERIAL COUNTY FARM BUREAU

The Imperial County Farm Bureau (ICFB) has initiated a "Voluntary Watershed Program." With joint funding from the IID and the ICFB, a consultant Watershed Program Director was contracted. In 1999, the ICFB (through the California Farm Bureau Federation [CFBF]) received a Clean Water Act Section 205(j) planning grant to support its Voluntary Watershed Program. The program elements include "outreach programs and mechanisms to encourage and foster an effective self-determined approach to attainment of TMDL load applications." The specific goals of the Voluntary Watershed Program include: (1) coordination of workshops with local technical assistance agencies, (2) development of local subwatershed ("drainshed") groups, (3) identification of leaders, within each of the local subwatershed groups, who will provide demonstration implementation sites for field-testing of BMPs, (4) cooperation with Regional Board staff to develop a process for the subwatershed groups to track and report planned and implemented on-the-ground implementation and effectiveness of BMPs, and (5) provide linkage to technical assistance agencies for BMP implementation assistance.

The ICFB has designated the geographical areas for ten (10) subwatershed groups, each covering approximately 50,000 acres of irrigated land. These geographical designations are to be utilized in the ICFB Voluntary Watershed Program's approach to education and implementation. Figure 7.1, located on the following page, shows the ten subwatershed designations.

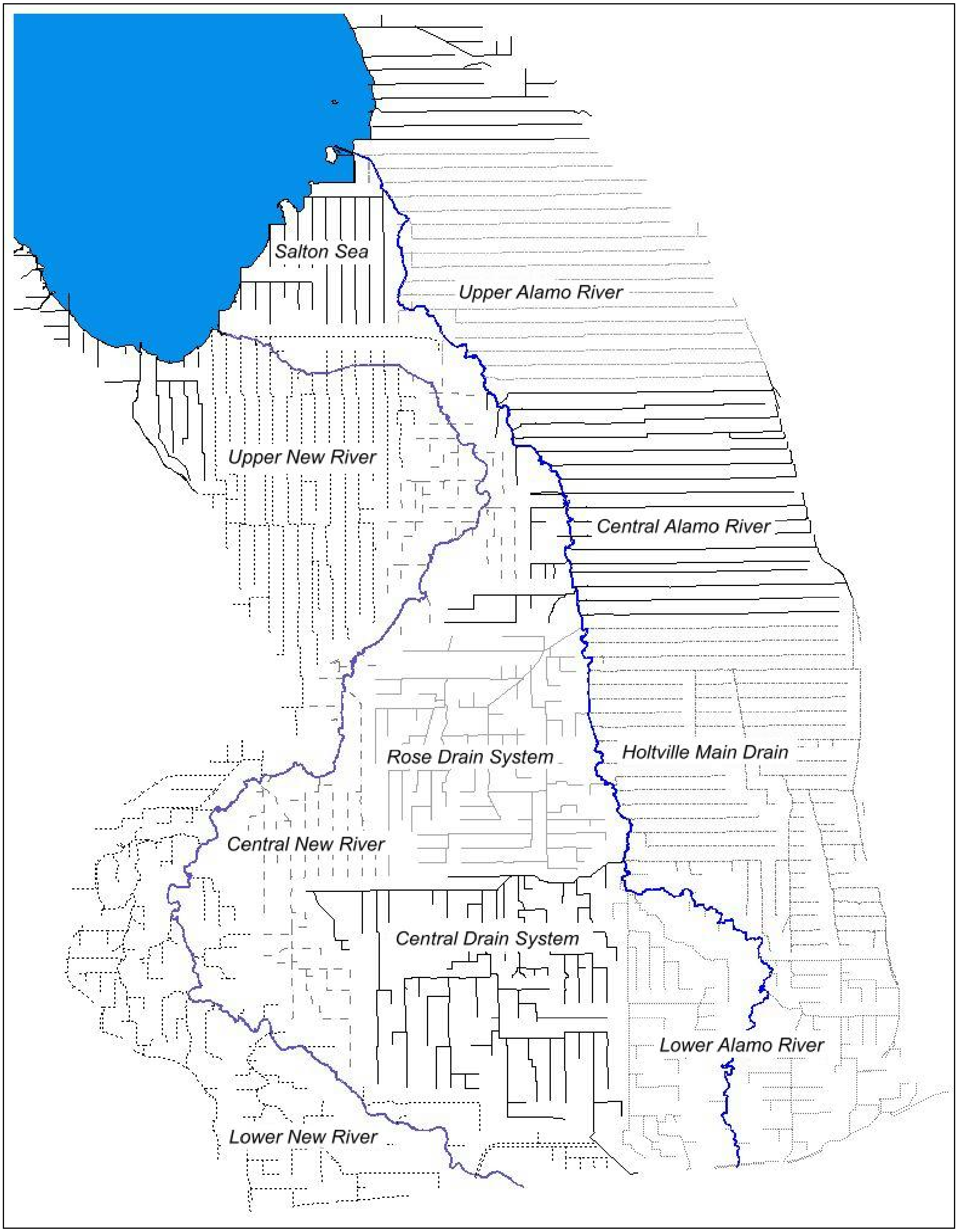

Figure 7.1: Map of Imperial County Farm Bureau Designated "Drainsheds"

7.3.3 UNITED STATES DEPARTMENT OF AGRICULTURE NATURAL RESOURCES CONSERVATION SERVICE (NRCS)

The Natural Resources Conservation Service (NRCS) is a Federal Assistance Agency. Its staff can provide technical assistance and aid in securing financial assistance to support the implementation of management practices. The NRCS also develops and maintains its *Field Office Technical Guide* (NRCS 1996), which contains technical standards and specifications of management practices.

7.4 DESIGNATED SEDIMENT MANAGEMENT ACTIONS TO BE TAKEN

This subsection describes: (1) the tiered regulatory approach of the Regional Board to be utilized in achieving attainment of the TMDL; (2) the nature of actions that are required of designated responsible parties; (3) the actions that cooperating third parties have agreed to undertake to facilitate the attainment of TMDL allocations through a self-determined process; and (4) the actions that dischargers may need to implement as components of either self-determined programs or under regulatory-encouraged compliance with the TMDL.

7.4.1 TIERED REGULATORY APPROACH

The implementation of this TMDL utilizes a three-tiered approach to NPS pollution control, consistent with the State's NPS Management Plan. The three tiers, as applied in this TMDL, are depicted below, in Figure 7.2.

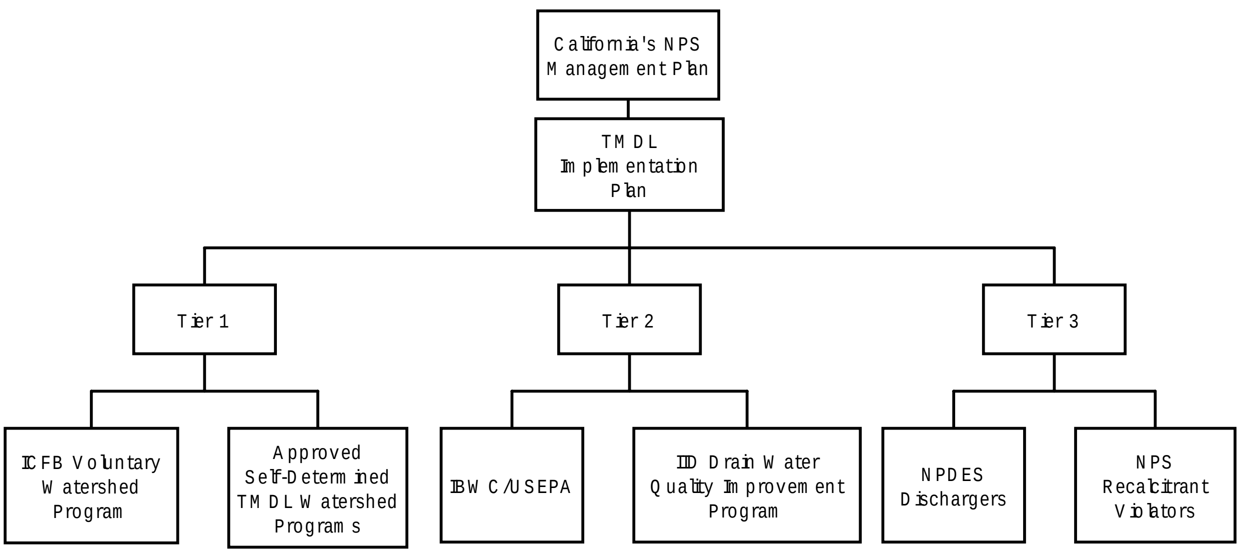

Figure 7.2: Schematic Representation of the Three-Tiered TMDL Implementation Approach

7.4.1.1 Tier 1 – Imperial County Farm Bureau Voluntary Program

The CFBF and ICFB have taken a proactive approach to educate, work with, and encourage farmers to develop and implement self-determined BMPs for sediment control through its Voluntary Watershed Program. The Regional Board fully supports this approach and will work closely with the ICFB to track implementation and effectiveness of BMPs, develop and implement water quality monitoring programs for the subwatershed, and provide regulatory guidance as needed. Within 80 days following <u>one year from USEPA adoption</u>, the ICFB has tentatively agreed to submit a list of participants in its Voluntary Watershed Program. It is expected that participants in the program will cooperatively develop a Subwatershed Plan, will further develop Farm Water Quality Management Plans, will report planned implementation activities and time-bound milestones to the ICFB, and will report completed implementation actions to the ICFB. The ICFB, in turn, will report the planned implementation activities and time-bound milestones to the Regional Board on a subwatershed basis (not on a field-by-field basis or on an operator-by-operator basis) and will report completed implementation actions to the Regional Board on a subwatershed basis. A conceptual flowchart depicting the ICFB Voluntary Watershed Program is shown in Figure 7.3, below.

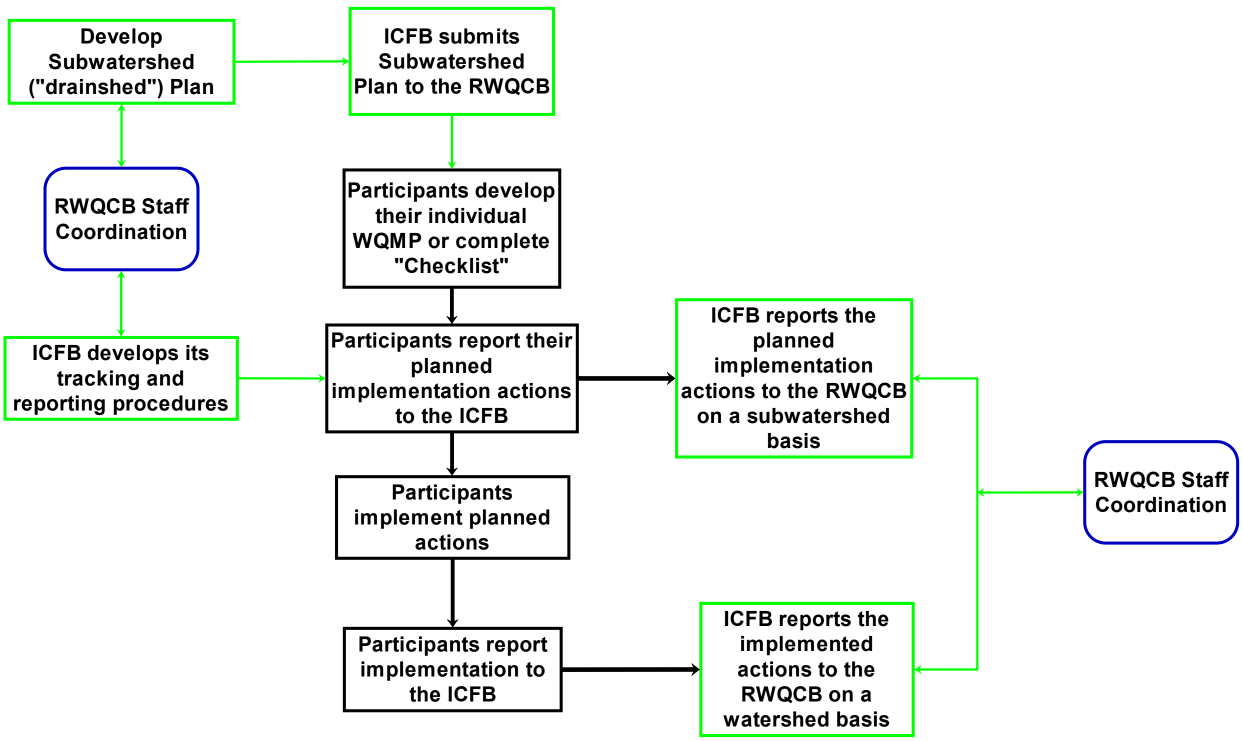

Figure 7.3: Flowchart Depiction of the ICFB Voluntary Watershed Program

Based on the foregoing, it is appropriate to specify the essential elements of the Farm Quality Management Plans. *Farm Water Quality Management Plans* (FWQMPs) are resource planning documents developed by individual owners/operators as part of the ICFB Voluntary Watershed Program to assess contributions to water quality problems and to determine corrective actions. An FWQMP needs to include the following elements:

1. Name of farm owner, business address, mailing address, and phone number

2. Name of farm operator/grower, business address, mailing address, and phone number

3. Inventory of resources (soils, animals, etc.);

4. Problem assessment (site conditions, crops, potential or current NPS problems);
5. Statement of goals (measurable outcomes or products);
6. Existing and/or alternative management practices (technical/economic feasibility, desired outcome, etc.);
7. Timetable for implementation (measured in either water quality improvement or level of implementation);
8. Monitoring (progress toward goals, effectiveness of management decisions); and
9. Mechanism for reporting planned and completed implementation actions to the Imperial County Farm Bureau (or other approved Self-Determined TMDL Watershed Program) and/or the Regional Board

Further, it is appropriate to request that the ICFB addresses Item Nos. 1 and 2, below.

1. ICFB WATERSHED PROGRAM PLAN

The Imperial County Farm Bureau should:

a. By (insert the date that corresponds to 30 days following <u>one year from USEPA adoption</u>)**, issue letters to all potential program participants within the Alamo River watershed that describe the ICFB Voluntary Watershed Program.

b. By (insert the date that corresponds to 150 days following <u>one year from USEPA adoption</u>)**, provide the Regional Board with a list of program participants, organized by subwatershed ("drainshed").

c. By (insert the date that corresponds to 120 days following <u>one year from USEPA adoption</u>) **, submit the ICFB Watershed Program Plan to the Regional Board. The Plan should (1) identify measurable environmental and programmatic goals; (2) describe aggressive, reasonable milestones and timelines for the development and implementation of TMDL outreach plans; (3) describe aggressive, reasonable milestones and timelines for the development of sub-watershed ("drainshed") plans; and (4) describe a commitment to develop and implement a tracking and reporting program.

d. Submit semi-monthly reports to the Executive Officer that describe the progress of each of the subwatershed groups, any technical assistance workshops that are planned or were conducted, and any other pertinent information.

2. ICFB TRACKING AND REPORTING PROCEDURES

The Imperial County Farm Bureau should also:

a. By (insert the date that corresponds to 180 days following <u>one year from USEPA adoption</u>), submit a plan describing the process and procedures for tracking and reporting

** Note: Upon State approval (i.e., approval by the Regional Board, the State Water Resources Control Board), this parenthetical "formula" will be replaced by the date certain, based on the date of approval.

implementation of BMPs (and other proven management practices) and BMP performance to the Regional Board's Executive Officer.

b. Implement the tracking and reporting procedures.

c. Submit semi-monthly written reports assessing trends in the data and level of adoption of the process and procedures throughout each of the sub-watersheds ("drainsheds") to the Executive Officer.

d. Submit a yearly summary report to the Executive Officer by 15th of February of each year.

If the ICFB does not develop the plans and mechanisms in accordance with the schedule set forth herein, the Regional Board will need to consider Tier 2 and Tier 3 regulatory approaches for individual dischargers.

7.4.1.2 Tier 1 – Other Approved Self-Determined TMDL Watershed Programs and Management Plans

Farmers/growers not participating in the ICFB Voluntary Watershed Program must submit self-determined sediment control programs to the Regional Board by {insert the date that corresponds 90 days following <u>one year from USEPA adoption</u>}[**]. A sediment control program may be submitted by an individual farmer/grower (hereafter "Individual Program") or by a group of farmers/growers (hereafter "Group Program"). In either case, the program must, at a minimum, address the following components:

1. Name of farm owner, business address, mailing address, and phone number;

2. Name of farm operator/grower, business address, mailing address, and phone number;

3. Problem assessment (site location by address and township-range coordinates; site condition(s), crop(s) typically grown in a five-year cycle and typical irrigation method for each crop; and potential or current NPS problems);

4. Statement of sediment control goals (measurable outcomes or products);

5. Existing and/or alternative sediment management practices (technical/economic feasibility, desired outcome, etc.);

6. Timetable for implementation of management practices (measured in either water quality improvement or level of implementation);

7. Monitoring for tailwater quality improvements, progress toward goals, and effectiveness of management decisions; and

8. Mechanism for reporting planned and completed implementation actions to the Regional Board

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[**] Note: Upon State approval (i.e., approval by the Regional Board, the State Water Resources Control Board), this parenthetical "formula" will be replaced by the date certain, based on the date of approval.

A group program may address Item Nos. 1 through 6, above, for the individuals enrolled in the program as a group. The program must nevertheless provide sufficient information so that the Regional Board can: (a) determine at a minimum on a drain- or drainshed-basis which responsible parties are enrolled in the program; (b) the types of sediment problems (i.e., severity, magnitude, and frequency) either the group as a whole or the drain/drainshed face; (c) the proposed sediment management practices for the group; and (d) the timetable for implementation of the management practices (measured in either water quality improvement and/or level of implementation). Regarding Item Nos. 7 and 8, above, a single monitoring and reporting plan may also be proposed for a group provided that the monitoring and reporting will provide results that are representative of the efficiency of various control practices within the group and representative enough to measure overall water quality improvements. Reported implementation of BMPs must be submitted to the Regional Board under the penalty of perjury.

All programs and reports specified herein are requested pursuant to Section 13267 of the California Water Code. In accordance with Section 13267(b)(2) of the California Water Code, when requested by the responsible party or group furnishing a program, the portions of a program, which might disclose trade secrets or secret processes, shall not be made available for inspection by the public but shall be made available to governmental agencies for use in making studies. However, these portions of a program shall be available for use by the Regional Board or any state agency in judicial review or enforcement proceedings involving the person or group of persons furnishing the report.

7.4.1.3 Tier 2 – Imperial Irrigation District

In 1994, the Regional Board's Executive Officer requested the IID take "accelerated action to address degraded water quality conditions in Imperial Valley drainage ways." In response, the IID submitted its Drain Water Quality Improvement Plan (DWQIP). The DWQIP was established in 1994 as Tier 2/regulatory-based encouragement for nonpoint source pollution control. IID implemented some short-term demonstrations of Best Management Practices (BMPs) to reduce sediment runoff and implemented a monitoring program in agreement with Regional Board staff from 1996 through 1997. As the Regional Board emphasis was shifted towards the TMDL process, the DWQIP was suspended in 1999 upon the recommendation of the Regional Board staff so that it could be revised/tailored to meet the needs of the TMDL process.

Consistent with that, and pursuant to CWC 13267, the IID must submit a revised DWQIP that includes proposed comprehensive water quality monitoring, measurements for sediment control, monitoring time schedules for implementation, and assurances for implementation. The sediment control measures must focus on the impacts caused by the operation and maintenance of the Alamo River watershed drainage system (e.g., dredging, vegetation removal, blown tailwater discharge pipes, etc.).

More specifically, by (insert the date that corresponds to 90 days following <u>one year from USEPA adoption</u>)[**], the IID must submit to the Regional Board a revised DWQIP with a proposed program to control and monitor water quality impacts caused by drain maintenance operations within the Alamo River Watershed and dredging operations in the Alamo River. The

[**] Note: Upon State approval (i.e., approval by the Regional Board and the State Water Resources Control Board, and the Office of Administrative Law), this parenthetical "formula" will be replaced by the date certain, based on the date of approval.

revised DWQIP must be subject to the approval of the Executive Officer and must address, but need not be limited to, items “1” and “2”, below:

1. Drain Maintenance and Alamo River Delta Dredging Controls

- Control measures to ensure that drainage maintenance operations[16] (e.g., dredging and vegetation removal) in the drains and in the Alamo River Delta do not cause exceedance of the TMDL;

- Timeline for implementation of control practices; and

- Mechanism(s) to assess performance of control practices.

Implementation of control practices must include appropriate seasonal restrictions to avoid impacts on sensitive resources, including the Alamo River Delta, and an appropriately certified CEQA document(s) for the practice(s) should the practice fall outside the scope of the functionally equivalent CEQA document certified by the Regional Board for this TMDL

2. Drain Water Quality Monitoring Plan

The revised DWQIP must consist of a proposed program to monitor:

- Water quality impacts caused by dredging operations in the drains and to monitor the effects that dredging operations in the Alamo River Delta have on water quality and the Delta habitat;

- Representative samples from the water column[17] of all major drains and a statistically representative number of the small drains tributary to the Alamo River for analyses of flow, TSS, Turbidity, selenium, total organic carbon, nutrients; and persistent pesticides such as DDT (and metabolites); pesticides that are applied by irrigation practices, such as ETPC; pesticides used as pre-emergents and post-emergents by crop and season; as well as the pesticides used for the control of weeds in drains and channels, such as diuron.;

- A statistically representative number of irrigation water locations for TSS;

- A statistically representative number of drains at a location sufficiently upstream of the outfalls to the river so as to provide an idea of how much silt is being taking care of by field BMPs; and

- Sediment impacts from storm events.

Also, no later than 120 days following <u>one year from USEPA adoption</u>), and on a semi-annual basis thereafter, the IID must submit to the Regional Board the following information on the agricultural dischargers within the District:

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[16] For the purpose of this Section, control practices should be prioritized based on feasibility and potential effectiveness and may include reduction and /or elimination of dredging operations in any particular area with the Alamo River Watershed.

[17] Samples collected from the last drain weir before the drain outfalls to the river will be considered representative of the water column

- The names and mailing addresses for all the owners of properties within the IID service area that are being used for irrigated agriculture, as well as the location of their properties.

- The names and mailing addresses for all water account holders within the IID service area, their water account number and the location of all fields that they irrigate.

- For each parcel within the IID service area, the location of the parcel, the irrigation canal and gates serving the parcel, the drop boxes draining the parcel, the drains that these drop boxes empty into, and the fields located within each parcel.

- For each field within the IID service area, the parcel within which each field is located, the area and location of each field within the parcel, the irrigation canal and gates serving each field, the drop boxes draining each field and the drains to which these drop boxes drain, and the crops being cultivated on each field.

(To the extent practical, the above information should be submitted in an electronic, tabular, and easily geo-referenced format.)

Further, no later than 60 days following the Executive Officer's approval of the revised DWQIP, the IID must submit to the Executive Officer a Quality Assurance Project Plan (QAPP) prepared in accordance with *Requirements for Quality Assurance Project Plans for Environmental Data Operations*, EPA QA/R-5, 1994 for the revised DWQIP. The QAAP is subject to the approval of the Executive Officer. No later than 30 days following the Executive Officer's approval of the QAPP, the IID must implement the QAPP and submit monthly, quarterly, and annual monitoring reports to the Executive Officer. The monthly reports are due on the 15th day of the month and must transmit the previous month's monitoring results, progress towards implementation of control practices, and performance of control practices. The quarterly reports are due on the 15th day of the month following the calendar's quarter and must transmit a quarterly summary of the results for the previous three months. The annual reports are due on February 15 and must summarize the year's data, quality control reports, and any trends in the data.

7.4.1.4 Tier 2 – The United States International Boundary and Water Commission (IBWC)

As part of the New River/Mexicali Sanitation Program, a weir was constructed in 1997 at the Alamo River in Mexico, immediately upstream of the border, to prevent dry weather flows from Mexico from ending up in the Alamo River in the U.S. However, as shown in the Source Analysis, Mexico's flows continue to come across the border because of lack of proper operation and maintenance of drains upstream of the weir, as documented by binational observation tour reports, including reports from IBWC and the Regional Board staff. Therefore, additional measures are necessary to address this problem.

With this in mind, and by (insert the date that corresponds to 90 days following one year from USEPA adoption)[**], the U.S. Section of the IBWC and/or USEPA must submit a technical report pursuant to CWC § 13225 describing the proposed measures the U.S. Government proposes to take to ensure that discharges of wastes from Mexico do not violate or contribute to a violation of the TMDL.

[**] Note: Upon State approval (i.e., approval by the Regional Board and the State Water Resources Control Board), this parenthetical "formula" will be replaced by the date certain, based on the date of approval.

7.4.1.5 Tier 2 and Tier 3- Individual Responsible Parties

As provided in the State Board's Water Quality Enforcement Policy, prompt, consistent, predictable, and fair enforcement are necessary to deter and correct violations of water quality standards, violations of the California Water Code, and to ensure that responsible parties carry out their responsibilities for meeting the TMDL allocations. This and progressive enforcement are particularly necessary to adequately deal with those responsible parties who fail to implement self-determined or regulatory-encouraged sediment control measures, which are essentially the cornerstone of the State NPS Management Plan. To this end, the Regional Board may use, as the circumstances of the case may warrant, any combination of the following:

- Implementation and enforcement of CWC § 13267 to ensure that all responsible parties submit, in a prompt and complete manner, the Water Quality Management Plan defined above;

- Consideration of adoption of waste discharge requirements, pursuant to CWC § 13263, as appropriate (i.e., for any responsible party who fails to implement voluntary or regulatory-encouraged sediment controls).

- Consideration of adoption of enforcement orders pursuant to CWC § 13304 against any responsible party who violates Regional Board waste discharge requirements and/or fails to implement voluntary or regulatory-encouraged sediment control measures to prevent and mitigate sediment pollution or threatened pollution of surface waters.

- Consideration of adoption of enforcement orders pursuant to CWC § 13301 against those who violate Regional Board waste discharge requirements and/or prohibitions.

- Consideration of Administrative Civil Liability Complaints, as provided for by the California Water Code, against any responsible party who fails to comply with Regional Board orders, prohibitions, and requests.

- Consideration of adoption of referrals of recalcitrant violators of Regional Board orders and prohibitions to the District Attorney or Attorney General for criminal or civil prosecution, respectively.

- In assessing the status of compliance with Load Allocations specified in Table 6.1 of any responsible party who is in either Tier I or Tier II, staff is recommending that the Regional Board consider, in addition to water quality results, the degree to which the responsible party has implemented, or is implementing, sediment control measures.

7.4.2 BEST MANAGEMENT PRACTICES

40 CFR 130.2(m) defines Best Management Practices (BMPs) as “methods, measures, or practices selected by an agency to meet its nonpoint source control needs. BMPs include but are not limited to structural and nonstructural controls and operation and maintenance procedures. BMPs can be applied before, during, and after pollution-producing activities to reduce or eliminate the introduction of pollutants into receiving waters.” 40 CFR 130.6(c)(4)(i) (nonpoint source management and control) states, “economic, institutional, and technical factors shall be considered in a continuing process of identifying control needs and evaluating and modifying the BMPs as necessary to achieve water quality goals.”

Implementation of BMPs should include: (1) consideration of specific site conditions; (2) monitoring to assure that practices are properly applied and are effective; (3) mitigation of a problem where the practices are not effective (including regulatory action, if necessary); and (4) improvement of a BMP or implementation of additional BMPs when needed to resolve a deficiency. (SWRCB, 2000)

Subsections 7.4.2.3 and 7.4.2.4 list sediment control BMPs. Inclusion of practices herein is not meant to imply a prescriptive list of "one size fits all" preferred practices be established for the drainage basins tributary to the Alamo River. Nor are the listed BMPs all-inclusive. Identification of the most appropriate controls to achieve TMDL attainment for site- and crop-specific conditions is best made by the landowners/operators, with assistance, as deemed necessary by the responsible parties, from technical resource agencies/organizations.

7.4.2.1 Institutional and Technical Considerations

The amount of irrigation-induced erosion and transport of sediment from an agricultural field into the drainage system is effected by several factors, including the:

- Irrigation methods (including flow rate of water runoff),
- Flow rate of inflow,
- Field size,
- Characteristics of the tailwater ditch,
- Effectiveness of any sediment BMPs utilized,
- Field gradient (downslope and sideslope),
- Crop type,
- Soil type
- Tillage practices, and
- Condition of the drop structure

The shearing force applied to the soils of the field by the irrigation water causes irrigation-induced erosion on an agricultural field. The total shearing force applied to a field will increase with increases in the velocity of the irrigation water, the depth of the irrigation water, and the total area and duration of contact between the soil and the irrigation water. The amount of sediment that will be detached and transported from the field by a given irrigation-induced shearing force is affected by the erosiveness of the soil types in the field, the condition of the soil structure in the field, and the presence and condition of vegetation within different areas of the field. In general, on-field sediment control BMPs work by limiting the velocity of the irrigation water and/or making the field more resistant to erosive forces.

In general, for an Imperial Valley field, the highest velocities and least vegetation are found at the bottom of the field, especially in the tailwater ditch. These factors make tailwater ditch erosion a major source of the sediment contributed to the drainage system. In addition, erosion at the bottom of the field tends to increase the slope of the field, therefore increasing velocity, and thus erosion, in the entire field. Other areas where erosion commonly occurs on an irrigated field include the drops from the furrows into the tailwater ditch, within the furrows themselves, and in the head ditch where water enters the field.

7.4.2.2 *Public Involvement in Identification/Development of BMPs*

During the course of TMDL development, the Technical Advisory Committee (discussed in Section 1.2) formed an "On-Field Sediment BMP Subcommittee" whose purpose was to "assess and provide recommendations and cost estimates of on-farm, silt-reduction BMPs." The Subcommittee prepared a list of recommended management practices. Additionally, the UCCE submitted a list of recommended management practices. The Subcommittee's list is contained in Appendix F; the UCCE's list is contained in Appendix G. Regional Board staff evaluated both lists of recommended BMPs and discussed the BMPs with TMDL TAC members on three different TAC meetings, at which TAC members and staff made revisions to the language. Those changes are incorporated herein.

7.4.2.3 *On-Field Sediment Control BMPs*

Under many circumstances, implementation of a combination of BMPs may be necessary to ensure that discharges do not adversely impact water quality. In addition, the effectiveness of many BMPs can be greatly increased when they are used in conjunction with other BMPs. The following on-field, sediment-control BMPs (references are in brackets) are available for implementation:

- **Imperial Irrigation District Regulation No. 39**
  Imperial Irrigation District's Regulation 39 states, in part, "It is the responsibility of each water user to maintain a tailwater structure and approach channel in acceptable condition, in order to qualify for delivery of water. An acceptable structure shall have vertical walls and a permanent, level grade board set a maximum of 12 inches below the natural surface. If the situation warrants, and at the discretion of the district, 18 inches maximum may be allowed."

  {Imperial Irrigation District Regulation No. 39, Silt TMDL TAC, Consistent with NRCS FOTG Conservation Practice "Structure for Water Control" (Code 587), Consistent with Jones & Stokes BMP #1: Improved Drop Box}

- **Tailwater Drop Box with Raised Grade Board**
  This practice involves maintenance of the grade board at an elevation high enough to minimize erosion. In many situations the grade board elevation can be set higher than required by the IID Regulations, especially when anticipated tailwater flows will not reach an elevation that will cause crop damage. Jones & Stokes' evaluation (1996) of this BMP rated it as having a demonstrated positive sediment transport reduction effect and a relatively low cost.

  {Silt TMDL TAC, Consistent with NRCS FOTG Conservation Practice "Structure for Water Control" (Code 587), Consistent with Jones & Stokes BMP #1: Improved Drop Box}

- **Improved Drop Box with Widened Weir and Raised Grade Board**
  This practice involves widening the drop box overpour weir and maintaining the grade board at an elevation high enough to minimize erosion. Widening the drop box overpour weir enables the weir elevation to be set higher without raising the surface elevation of the water above the acceptable level. Higher weir elevations allow for an increased tailwater ditch cross section, and reduced erosion when water leaving the field enters the tailwater ditch. Jones & Stokes' evaluation (1996) of this BMP rated it as having a demonstrated positive sediment transport reduction effect (sediment reduction efficiency of 40 to 60%) and a relatively low cost.

{Silt TMDL TAC, Consistent with NRCS FOTG Conservation Practice “Structure for Water Control” (Code 587), Jones & Stokes BMP #1: Improved Drop Box}

- **“Pan Ditch” -- Enlarged Tailwater Ditch Cross Section**
  This practice involves deepening and widening the tailwater ditch, which will result in decreased tailwater velocity and depth. The water must be checked up downstream of the oversized area to make the cross section of the water as large as practical. The slower the velocity, the more sediment will settle out of the water and stay in the field, and the less will be picked up by the moving water. Planting grass filter strips in the tailwater ditch and/or installing tailwater ditch checks can further improve the effectiveness of this BMP.

  {Silt TMDL TAC}

- **Tailwater Ditch Checks or Check Dams**
  Tailwater Ditch Checks are temporary or permanent dams that hold the water level well above the ground. They can be placed at intervals in tailwater ditches, especially those with steeper slopes. They increase the cross section of the stream of water, decrease the water velocity and reduce erosion, and may cause sediment already in the water to settle out. Tailwater Ditch Checks can be constructed of plastic, concrete, fiber, metal or other suitable material. If plastic sheets are used, care must be taken not to allow pieces of the plastic to be carried downstream with the water. In order to be effective, this BMP must be utilized in conditions where water velocities will not wash out the check dams or the sides of the tailwater ditch around the dams. Tailwater ditch checks or check dams are expected to work best in wide “pan ditches” where the width of the tailwater stream can be effectively increased. Jones & Stokes’ evaluation (1996) of this BMP rated it as having a likely positive effect on sediment transport reduction and a relatively low cost.

  {Silt TMDL TAC, Jones & Stokes BMP #2: Portable Check Dams}

- **Field to Tailditch Transition**
  This practice involves controlling the flow of water from the field into the tailwater ditch through use of spillways or pipes that allow the tailwater to fall down into the tailwater ditch from the field without washing across and eroding the soil. Spillways might be constructed of plastic, concrete, metal, or other suitable material. If plastic sheets are used, care must be taken not to allow deterioration to cause pieces of the plastic to be carried downstream with the water. This procedure may be useful on fields irrigated in bordered-strips and furrows. Care must be taken to address erosion that may be caused in the tailditch at the location where the spillway discharges to the tailditch. Regional and site-specific effectiveness of BMPs will be determined through local monitoring and assessment.

  {Silt TMDL TAC}

- **Irrigation Land Leveling**
  This practice involves maintaining or adjusting field slope so as to avoid excessive slopes or low spots at the tail end of a field. In some cases it might be advantageous to maintain a reduced main or cross slope, which facilitates more uniform distribution of irrigation water and can result in reduced salt build-up in the soil, increased production, reduced tailwater, and decreased erosion. Jones & Stokes’ evaluation (1996) of this BMP rated it as having a sediment reduction efficiency of 10 to 50% and a medium to high cost.

  {Silt TMDL TAC, Consistent with NRCS FOTG Conservation Practice “Irrigation Land Leveling” (Code 464), Jones & Stokes BMPs #13 and #14: Land Leveling, Slope Adjustments, Tail End Flattening, and Dead Leveling}

- **Filter Strips**

  This practice involves elimination of borders on the last 20 to 200 feet of the field. Planted crop is maintained to the end of the field and tailwater from upper lands is used to irrigate the crop at the ends of the adjacent lower lands. It is important that the main slope on the lower end of the field is no greater than on the balance of the field. A reduced slope might be better. With no tailwater ditch, there should be very little erosion as the water slowly moves across a wide area of the field to the tailwater box. Some sediment might settle out as the crop slows the water while it moves across the field. This could be used with water tolerant crops or special soil conditions. Jones & Stokes' evaluation (1996) of this BMP rated it as having a demonstrated positive sediment transport reduction effect (sediment reduction efficiency of 40 to 65%) and a relatively low to medium cost.

  {Silt TMDL TAC, Consistent with NRCS FOTG Conservation Practice "Filter Strip" (Code 393), Jones & Stokes BMPs #4: Filter Strips}

- **Irrigation Water Management**

  Irrigation Water Management is defined as determining and controlling the rate, amount, and timing of irrigation water in a planned manner. Effective implementation of this practice can result in minimizing on-farm soil erosion and the subsequent transport of sediments into receiving waters. Specific methods of Irrigation Water Management include: Surge Irrigation, Tailwater Cutback, Irrigation Scheduling, and the Runoff Reduction Method**.** In some cases, irrigation water management could include the employment of an additional irrigator to assist in better monitoring and managing irrigation water and addressing potential erosion problems.

  {Consistent with NRCS FOTG Conservation Practice "Improved Water Application" (Code 197, CA Interim), Consistent with NRCS FOTG Conservation Practice "Irrigation Water Management" (Code 449), Jones & Stokes BMPs #8: Improved Irrigation Scheduling, #9: Gated Pipe Irrigation, #11:Cut-Back Irrigation, #12: Cablegation, #15: Surge Irrigation}

- **Sprinkler Irrigation**

  Sprinkler irrigation involves water distribution by means of sprinklers or spray nozzles. The purpose of this practice is to efficiently and uniformly apply irrigation water to maintain adequate soils moisture for optimum plant growth without causing excessive water loss, erosion, or reduced water quality. Jones & Stokes' evaluation (1996) of this BMP rated it as having a demonstrated positive sediment transport reduction effect (sediment reduction efficiency of 25 to 35% if utilized during germination and 90 to 95% for an established crop) and a relatively high cost.

  {Consistent with NRCS FOTG Conservation Practice "Irrigation System, Sprinkler" (Code 442), Jones & Stokes BMPs #17 and #18: Irrigation Sprinkler Systems}

- **Drip Irrigation**

  Drip irrigation consists of a network of pipes and emitters that apply water to the surface or subsurface of the soil in the form of spray or a small stream.

- **Reduced Tillage**

  This practice is the elimination of at least one cultivation per crop. It integrates weed control practices in order to maximize the effectiveness of cultivating weed control, but at the same time minimize erosion and sedimentation that may occur in the furrow.

- **Furrow Dikes (also known as "C-Taps")**

Furrow dikes are small dikes created in furrows to manage the velocity of the water in the furrow. They can be either constructed of earth and built with an attachment to tillage equipment, pre-manufactured “C-Taps,” or other material, including rolled fiber mat, plastic, etc. Jones & Stokes’ evaluation (1996) of this BMP rated it as having a likely positive sediment transport reduction effect and a relative low cost.

7.4.2.4 Off-Field Sediment Control BMPs

The following practices are defined as off-field sediment-control BMPs (references are in brackets):

- **Channel Vegetation / Grassed Waterway**
  This practice involves establishing and maintaining adequate plants on channel banks and associated areas to stabilize channel banks and adjacent areas and reduce erosion and sedimentation, and establishing maximum side slopes. This practice serves to stabilize the channel bank, reducing the potential for bank failure.

  {Consistent with NRCS FOTG Conservation Practice “Channel Vegetation” (Code 322), and NRCS FOTG Conservation Practice “Grassed Waterway” (Code 412)}

- **Irrigation Canal or Lateral**
  This practice applies to irrigation drainage channels. One objective of the practice is to prevent erosion or degradation of water quality. Drainage channels should be designed to develop velocities that are non-erosive for the soil materials of which the channel is constructed.

  {Consistent with NRCS FOTG Conservation Practice “Irrigation Canal or Lateral” (Code 320)}

- **Sediment Basins**
  Sediment basins are constructed to collect and store debris or sediment. The capacity of the sediment basin should be sufficient to store irrigation tailwater flows for long enough to allow most of the sediments within the water to settle out. The sediment basins also must be cleaned regularly to maintain their capacity and effectiveness.

7.4.3 EFFECTIVENESS MONITORING

Effectiveness monitoring (also known as management monitoring) is used to evaluate the effectiveness of a BMP/management practice or set of BMPs/management practices. Effectiveness monitoring efforts should be implemented in conjunction with technical assistance in order to ensure that the monitoring data will be useful in assessing the effectiveness of the activities.

There is currently a lack of quantitative data on the performance of applicable BMPs under local conditions. Performance data will be considered in future revisions to the TMDL. Regional Board staff will work cooperatively with the ICFB and its subwatershed groups and the IID to determine appropriate monitoring protocols and tracking/reporting protocols to assess BMP performance. The UCCE also can play an important role in assessing BMP performance.

“Sediment BMP Performance” is defined as:

Sediment BMP Performance = TSS (No BMP) – TSS (With BMP)

or

$$\text{Sediment BMP Performance} = \frac{\text{Tons of sediment}}{\text{Year}}\text{(No BMP)} - \frac{\text{Tons of sediment}}{\text{Year}}\text{(With BMP)}$$

[Equation 8]

and "Sediment BMP Efficiency" is defined as:

$$\text{Sediment BMP Efficiency} = 100 * \frac{TSS_{no\ BMP} - TSS_{with\ BMP}}{TSS_{no\ BMP}}$$

or

$$100 * \frac{\text{Tons of Sediment/Year (No BMP)} - \text{Tons of Sediment/Year (With BMP)}}{\text{Tons of Sediment/Year (No BMP)}}$$

[Equation 9]

Where:

$TSS_{No\ BMP}$ = TSS concentration without BMP under a specified set of operational conditions
$TSS_{With\ BMP}$ = TSS concentration with BMP under the same specified set of operational conditions

7.5 SEDIMENT TMDL ADAPTIVE MANAGEMENT COMMITTEE

The Regional Board Executive Officer will establish an Adaptive Management Committee (AMC) comprised of representatives of various stakeholder groups and agencies. The AMC will meet on at least a semi-annual basis. Regional Board staff will provide the AMC with formal results of water quality monitoring and tracking activities. The charge of the AMC will be to evaluate overall BMP implementation and performance, evaluate water quality improvements, and make appropriate recommendations for TMDL compliance and/or modifications. In addition, the Imperial Irrigation District and the Imperial County Farm Bureau will be given the opportunity to report on their progress toward attainment of the milestones set forth in this plan, and toward attainment of the milestones set forth in Plans submitted pursuant to this Implementation Plan.

Proven BMPs are currently available to address sediment loading to the Alamo River. Therefore, this implementation plan does not require a schedule for the development of management practices. However, through the Adaptive Management Committee and/or the subwatershed groups, BMPs can be prioritized for refinement and performance assessment, and new management practices can be identified.

7.6 WATER QUALITY IMPROVEMENT GOALS

It is the goal of the Regional Board to see attainment of the Alamo River Sedimentation/Siltation TMDL allocations by the year 2013. Time-bound interim numeric targets and reduction goals are shown in Table 7.1, below:

Table 7.1: Interim Numeric Targets for Attainment of the TMDL[1]

Phase	Time Period[2]	Estimated Percent Reduction[3]	Interim Target[4]
Phase 1	2001 through 2003 (Years 1 – 3)	15%	320
Phase 2	2004 through 2007 (Years 4 – 7)	25%	240
Phase 3	2008 through 2010 (Years 8 – 10)	10%	216
Phase 4	2011 through 2013 (Years 11 – 13)	8%	200

1. For purposes of measuring compliance, all samples will be analyzed for volatile suspended solids at locations where organic loading represents a significant proportion of the total suspended solids or turbidity. The volatile suspended solids will be subtracted for determining compliance.

2. Year 1 refers to the effective date to start TMDL implementation, which shall be one year after USEPA approves the TMDL. For example, if USEPA approves the TMDL on November 15, 2001, Year 1 is November 15, 2002, which makes Year 3 November 15, 2005, which makes Year 4 November 15, 2006, and so on.

3. Percent reductions indicate the reduction required in total suspended sediment load from the average concentration of the Alamo River at the beginning of each phase, beginning with the 1980-2000 average concentration of 377 mg/L.

4. These interim targets are goals which translate current silt/sediment related Basin Plan narrative objectives and are not intended to specifically be used for enforcement purposes.

From the standpoint of measuring progress, any cropland discharge with a concentration of suspended solids, measuring more than 375 mg/l (or about 270 NTU for turbidity) and absent reasonable implementation of BMPs would be considered unsatisfactory.

7.7 REGIONAL WATER QUALITY CONTROL BOARD MONITORING & TRACKING PLAN

This subsection describes the monitoring and surveillance actions to be undertaken by the Regional Board to measure compliance with the TMDL. Tracking TMDL implementation, monitoring water quality progress, and modifying TMDLs and implementation plans as necessary to ensure attainment of water quality standards is important to:

- Address uncertainty that may exist in aspects of TMDL development;
- Oversee TMDL implementation to ensure that implementation is being carried out;
- Ensure that the TMDL remains effective, given changes that may occur in the watershed after the TMDL is developed.

Regional Board staff will implement two types of monitoring: (1) water quality monitoring and (2) implementation tracking.

7.7.1 WATER QUALITY MONITORING

Monitoring activities conducted as part of the Alamo River Sedimentation/Siltation TMDL Monitoring and Tracking Program will be conducted pursuant a Regional Board Quality Assurance Project Plan (QAPP). The QAPP will be developed by Regional Board staff and submitted to USEPA for approval within 150 days of adoption of this TMDL and Implementation Plan by the State Board.

7.7.1.1 Objectives

The objectives of the monitoring program include collection of water quality data for the:

- Assessment of water quality standards attainment,
- Verification of pollution source allocations,
- Calibration or modification of selected models (if any),
- Calculation of dilutions and pollutant mass balances,
- Evaluation of point and nonpoint source control implementation and effectiveness,
- Evaluation of in-stream water quality, and
- Evaluation of temporal and spatial trends in water quality.

7.7.1.2 Minimum Locations and Sample Types

Representative Grab samples taken will be taken at the following stations:

- Alamo River at AR-0[18]
- Alamo River at AR-1
- Alamo River at AR-2
- Alamo River at AR-3
- Alamo River at AR-4
- Alamo River at AR-5
- Alamo River at AR-Outlet[18]

7.7.1.3 Minimum Sample Parameters and Sample Frequency

- Flow [Quarterly]
- Field turbidity [Quarterly]
- Lab turbidity (EPA Method No. 180.1) [Quarterly]
- Total Suspended Solids (EPA Method No. 160.2) [Quarterly]
- Ortho Phosphate (EPA Method No. 300.0) [Quarterly]
- Total Phosphorus (EPA Method No. 365.2 or 365.3) [Quarterly]
- Total DDT (EPA Method No. 8081) [Annually]
- Selenium – [Quarterly}

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[18] To the extent that resources provide, a station will be deployed at these locations of the river to obtain continuous data on suspended solids indicator parameters (e.g., turbidity) using optical backscatter instrumentation and correlate the data with the grab sample data.

7.7.2 SURVEILLANCE AND IMPLEMENTATION TRACKING

Within 180 days of USEPA approval of this TMDL and Implementation Plan by the State Board, Regional Board staff will develop a plan for tracking implementation of this TMDL. The objectives of the plan are:

- Assess/track/account for practices already in place,
- Measure the attainment of Milestones,
- “Ground-truth” the level of implementation, and
- Report progress toward implementation of NPS water quality control, in accordance with the SWRCB NPS Program Plan.

7.8 MEASURES OF SUCCESS & RAMIFICATIONS OF FAILING TO MEET MILESTONES

7.8.1 MEASURES OF SUCCESS

The primary measure of success for implementation of this TMDL is attainment of interim numeric targets and corresponding interim load allocations, with the final goal of attainment of the final TMDL load allocations. However, recognizing that many factors may affect the attainment of the TMDL, other measures of success, including attainment of implementation milestones and level of compliance with Tier 2 and Tier 3 requirements, will be considered in evaluating implementation of the TMDL. As explained in Section 7.9, below, Regional Board staff will prepare quarterly reports for the Regional Board that assess the factors including water quality and implementation. And, as discussed in Section 7.9.2, the Regional Board will consider revising its TMDL on a triennial basis (approximately every three years).

7.8.2 FAILURE SCENARIOS

There are two “failure scenarios” for self-determined TMDL implementation. The first of these is a failure to meet water quality improvement goals (interim numeric targets and corresponding interim load allocations) coupled with achievement of implementation milestones. Under this scenario, the BMPs and interim targets will be re-evaluated and adjusted. The second failure scenario involves failure to meet water quality improvement goals (interim numeric targets and corresponding interim load allocations) coupled with failure to achieve implementation milestones. Under the second scenario, the Regional Board shall consider more stringent regulatory mechanisms, consistent with the State’s NPS Management Policy and the State’s Enforcement Guidance.

7.9 REVIEW SCHEDULE FOR TMDL

7.9.1 QUARTERLY REPORTS TO THE REGIONAL BOARD

Regional Board staff is committed to on-going assessment and evaluation of this TMDL and intends to present quarterly reports to the Regional Board describing progress toward attainment of milestones. The reports will assess:

- Water quality improvement (in terms of total suspended sediments, total sediment loads, DDT and metabolites, total phosphate),

- Trends in BMP implementation,
- BMP effectiveness/performance,
- Whether milestones were met on time or at all. If milestones were not met, provide a discussion of the reasons,
- Level of compliance with measures and timelines agreed to in Program Plans and associated time schedules, and
- Level of compliance with measures and timelines agreed to in Drainshed Plans.

7.9.2 TRIENNIAL REVIEW

Section 303 of the Clean Water Act requires that the State hold public hearings for the purpose of reviewing applicable water quality standards (WQS), and as appropriate, modifying and adopting standards. 40 CFR 130 also prescribes this requirement. Further, Section 13240 of the California Water Code requires the State to formulate regional water quality control plans and periodically update the plans. Following adoption by the Regional Board, basin plan amendments and supporting documents are submitted to the SWRCB for review and approval. Following the approval of the SWRCB, basin plan amendments must also be reviewed by the State Office of Administrative Law. In addition, the USEPA has approval authority over Basin Plan Amendments.

In order to provide adequate time for implementation and data collection and assessment, the first review of the TMDL will be scheduled to conclude three years after the adoption of the TMDL. Subsequent reviews will be conducted concurrent with the Triennial Review of the Basin Plan. The TMDL review schedule is shown below in Table 7.2.

Table 7.2: TMDL Review Schedule*

Activity	Date
Adoption	2001
Begin Review	July 2003
End Review (Regional Board Public Hearing)	April 2004
Submit Administrative Record to SWRCB	May 2004
Begin Review	July 2005
End Review (Regional Board Public Hearing)	June 2006
Submit Administrative Record to SWRCB	July 2006
Begin Review	July 2008
End Review (Regional Board Public Hearing)	June 2009
Submit Administrative Record to SWRCB	July 2009
Etc.	

* Dates are contingent upon the approval of the Regional Board and the SWRCB.

Staff proposes that the Regional Board hold public hearings at least every three years to review the progress of the sediment control program. At these hearings, it is proposed that the Regional Board consider:

- Monitoring results to date,
- Progress toward attainment of milestones,
- Changes or trends in implementation of BMPs,
- Modification/addition of management practices for the control of sediment discharges, and
- Revision of TMDL components and/or development of site-specific water quality objectives.

7.9.3 COMPLIANCE REVIEW CONSIDERATIONS

On a yearly basis, the Regional Board staff will prepare a report assessing compliance with the TMDL Goals and Milestones. In the report, staff will assess the following:

- Water quality improvement (in terms of total suspended sediments, total sediment loads, DDT and metabolites, total phosphate),
- Trends in BMP implementation,
- BMP effectiveness/performance,
- Whether milestones were met on time or at all. If milestones were not met, provide a discussion of the reasons, and a recommendation,
- Level of compliance with measures and timelines agreed to in Program Plans and associated time schedules, and
- Level of compliance with measures and timelines agreed to in Drainshed Plans.

8. PROPOSED AMENDMENT

Attachment 1 includes a draft Regional Board Resolution to adopt the draft Basin Amendment (Attachment 2) establishing this TMDL and TMDL Implementation Plan.

The draft Basin Plan Amendment:

- Updates references to the State's Nonpoint Source Pollution Control Program
- Includes the elements of the Regional Nonpoint Source Control Program
- Deletes dated information that is no longer accurate
- Establishes a site specific water quality objective for the Alamo River of 200 milligrams per liter of total suspended solids for the entire US length of the River.
- Adds a Section for this TMDL that:
  - Summarizes the "technical" TMDL elements, including the Problem Statement, Numeric Target, Source Analysis, Margin of Safety, Seasonal Variation/Critical Condition information, Loading Capacity, and Allocations
  - Establishes interim numeric targets
  - Designates Responsible Parties and Management Actions
  - Lists available sediment control Best Management Practices
  - Describes the recommended actions for cooperating agencies
  - Describes compliance assurance and enforcement activities for this TMDL
  - Describes Regional Board monitoring, tracking, and assessment activities to monitor the implementation of this TMDL
  - Describes the public reporting activities for this TMDL
  - Describes the Regional Board review process for this TMDL.

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9. ENVIRONMENTAL CHECKLIST

The Secretary of Resources has certified the basin planning process as exempt from certain requirements under the California Environmental Quality Act (CEQA), including preparation of an initial study, a negative declaration and environmental impact report [Title 14, California Code of Regulations, Section 15251(g)]. As this proposed amendment to the *Basin Plan* is part of the basin planning process, the amendment is considered ‘functionally equivalent’ to an initial study, a negative declaration and an environmental impact report. Included in the 'functionally equivalent' amendment are: Alamo River Sedimentation/Siltation Total Maximum Daily Load; Draft Resolution; Basin Plan Amendment; CEQA Checklist; Natural Environment Study; and, Economic Analysis of the Alamo River Sedimentation/Siltation TMDL.

The CEQA Checklist (Contained in Attachment 3) notes that the impacts associated with the Basin Plan amendment are less than significant with mitigation. The CEQA discussion accompanying the Checklist (Contained in Attachment 3) summarizes the types of impacts that may occur as a result of the implementation of sediment control measures. As the implementation program is developed, the Regional Board will amend the Basin Plan and consider any impacts associated with resulting amendments.

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10. ECONOMIC IMPACTS TO AGRICULTURE

Section 13141 of the Porter-Cologne Water Quality Control Act requires the Regional Board to estimate the cost of any agricultural water quality control program prior to requiring its implementation, and to identify funding sources.

10.1 SUMMARY OF COST ANALYSIS

The SWRCB Economics Unit prepared a Cost Analysis (Attachment 4) that evaluates the cost of implementation of several alternative management practices for the farmers. After omitting the high-cost outlier, the annual costs – for the various irrigation drainage management practices reviewed – range from a low of about $6 per acre for the wide-profile ditch to a high of about $40 per acre for additional vegetable irrigation labor. Although this cost range appears to be quite broad, a comparison on a cost-share basis reveals that both amounts represent increases of up to 1% in per-acre gross production costs for field crops (annual production costs of $500 - $800) and vegetables (annual production costs of $3,000 - $5,000); this cost-share comparison is less accurate for non-vegetable row-crops, that have production costs of about $1,500 per acre. Specific Imperial County crop production costs were obtained from reports compiled by the University of California Cooperative Extension.

The one-time cost for individual farmers/operators for preparing the water quality improvement plan ("Individual Program") required by Section 7.4.1.2 is estimated to be less than $200. Monitoring costs for individual farmers/operators could range from $100 to $500 per irrigation season, depending on the monitoring program.

At this point, it is uncertain what BMPs the IID may implement to comply with its TMDL requirements. If the IID chooses to decrease its dredging and vegetation removal operations for the watershed as one of the means for compliance with the TMDL, this does not result in an increased cost. In fact, this may result in an economic savings to the IID. There are, however, costs associated with the preparation and implementation of the Quality Assurance Project Plan for a revised Drain Water Quality Improvement Plan specified in Section 7.4.1.3. The preparation of the QAPP could exceed $25,000 according to the IID (IID, 2000). Regional Board staff estimates that implementation of the QAPP can cost as much as $70,000 per year, and that the characterization of dredging impacts can cost about $20,000. According to data in Attachment 4, the cost savings to the IID are estimated at about $100,000 per year. If this savings is passed on to the farmers, the net savings (dredging savings minus costs for preparing and implementing the QAPP and characterizing dredging impacts) will be about twenty cents per acre. The magnitude of these cost savings is significantly smaller than the magnitude of the cost of the BMPs, that have a lower-end cost of about $5 to $13 per acre.

10.2 TECHNICAL ASSISTANCE

10.2.1 FEDERAL

U.S. Department of Agriculture's Natural Resources Programs

The U.S. Department of Agriculture (USDA) Natural Resources Conservation Service (NRCS) offers landowners financial, technical, and educational assistance to implement the conservation practices on privately owned land. These programs include the following:

- *Environmental Quality Incentives Program* (EQIP) offers financial, educational, and technical help to install or implement BMPs such as manure management systems, pest management, and erosion control, to improve the health of the environment. Cost-sharing may pay up to 75% of the costs of certain conservation practices.

- *National Conservation Buffer Initiative* created to help landowners establish conservation buffers, which can include riparian areas along rivers, streams, and wetlands. NRCS is the lead agency in cooperation with others.

Clean Water Act Section 319(h)
Federal nonpoint source water quality implementation grants are offered each year on a competitive basis. These grants can range from $25,000 to $350,000 and require a 40% non-Federal match. The grants are administered through the Regional Water Quality Control Board.

Clean Water Act Section 205(j)
Federal water quality planning grants are available each year on a competitive basis. These grants can range from $25,000 to $120,00 and require a 25% non-Federal match. The grants are administered through the Regional Water Quality Control Board.

10.2.2 STATE

University of California Cooperative Extension Programs
The UC Cooperative Extension can offer technical assistance regarding BMPs and erosion control.

California Regional Water Quality Control Board
The Regional Board staff is available on a case-by-case basis for consultation on regulatory matters (e.g., water quality improvement plan requirements) and guidance on water quality monitoring.

10.2.3 LOCAL INSTITUTIONS

Imperial County Farm Bureau has establish its *V*oluntary Watershed Program, which can assist farmers to track implementation and effectiveness of BMPs, develop and implement water quality monitoring programs at the subwatershed level and provide regulatory guidance as needed.

10.3 POTENTIAL FUNDING SOURCES

The following are potential sources of funding:

1. Private financing by individual sources.

2. Bond indebtedness or loans from government institutions.

3. Surcharge on water deliveries to lands contributing to the sediment pollution problem.

4. Taxes and fees levied by the Irrigation District that provides drainage management.

5. State and/or Federal grants and low-interest loans, including State Proposition 13 (Costa-Machado Act of 2000) grant funds and Federal Clean Water Act Section 319(h) grant funds.

6. Single purpose appropriations from Federal and/or state legislative bodies.

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